ACTIVITY OF GROUP-TRANSPORTED HORSES DURING ONBOARD REST STOPS

A Thesis

by

HEIDI A. KEEN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2005

Major Subject: Animal Science

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Approved by:

Chair of Committee,	Theodore H. Friend
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ABSTRACT

Activity of Group-Transported Horses During Onboard Rest Stops. (December 2005)

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Activity of group-transported horses was evaluated during onboard rest stops to determine if horses derive meaningful rest. A single-deck semi-trailer separated into three compartments was used for all shipments. In Experiment One, twelve video cameras were used to record behavior of horses during five, 16 to 20 h shipments, with a high (397.44kg/m^2), medium (348.48 kg/m^2) and low (220.91 kg/m^2) density group in each shipment. One-hour rest stops occurred after 8 h of transport and prior to unloading, during which two groups were provided water. Movement of each horse visible on video was quantified by counting the number of times the head crossed the vertical and/or horizontal axes of the body at the withers. Mean number of movements per 5-min interval in each group (n=13) was used to compare effects of density, access to water, and order of stops. The high and low-density watered groups had increased activity during the first 10 min of both rest stops potentially due to maneuvering for access to water. The medium-density watered groups had increased activity during the first 10 min of only the second rest stop. Activity slightly increased in the medium and low-density groups after 55 min possibly indicating adequate rest, but a similar increase did not occur in high-density groups. In Experiment Two, two shipments, lasting 23 h and 24 h respectively, consisted of three groups of horses loaded at high density (397.32 kg/m^2). Ninety-minute rest stops occurred after every 6 h of transport and prior to unloading for a total of three

rest stops. Percentage of visible horses “active” was averaged across each 5-min interval of the stop. Activity was highly variable within and between shipments. Activity was high at the beginning of stops one and three of Shipment One. A similar but less dramatic settling occurred at the start of all three rest stops in Shipment Two. Twenty three of thirty-four noted increases in alertness were due to aggression or noises outside the trailer. In both experiments horses remained active during all stops indicating fatigue had not become a major factor in these studies.

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"You give but little when you give of your possessions. It is when you give of yourself that you truly give."

- Kahlil Gibran, *The Prophet*

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INTRODUCTION

There is great concern for the welfare of horses being transported to slaughter. While the numbers of horses being slaughtered in the U.S. has decreased yearly from 72,120 in 1998 to 66,183 in 2004 (USDA, 1999 and 2005), the length of transport is still grounds for concern due to the limited number and central location of facilities. Currently, only three horse slaughter facilities operate in the U.S., one in Illinois and two in Texas, resulting in transports lasting up to 28 h. Following the passing of the Safe Commercial Transportation of Horses to Slaughter Act in 1996, USDA-APHIS-Veterinary Services began funding research to develop regulations for the transport of horses to slaughter (Reece et al., 2000). To date, studies have focused on characterizing horses going to slaughter and determining the effects of loading density and provision of water on horses in transport, but no research has been done on the resting of horses during transport to slaughter.

This thesis follows the style and format of Journal of Animal Science.

FACTORS AFFECTING REST BEHAVIOR DURING LONG-DISTANCE TRANSPORTATION

Horses are generally used as recreational or sporting animals; therefore the majority of research on their transportation is related to conditions which favor their subsequent performance. In contrast, research pertaining to the transport of slaughter horses takes a more economics based approach. While suggestions of paying drivers and handlers in such a way that penalizes them for carcass bruising may facilitate better driving (Broom, 2003), other factors such as density, transport duration, rest, and provision of food and water should also be considered in attempts to alleviate additional stressors and maintain market value of the animals. Given the greater economic importance of typical meat animals, such as cattle and sheep, the majority of research on transport has been conducted using these species.

Loading and unloading are commonly considered the most stressful component of transportation. Irwin and Gentleman (1978) concluded that unloading cattle for less than 48 h while in transit may be more detrimental than direct transport. Warriss (1990) hypothesized that crowding, poor footing, and potential overuse of sticks contributed to greater bruising of cattle going to auction before slaughter rather than directly to slaughter in a previous study by Eldridge et al. Carcass bruising was also correlated with higher densities but not location in the truck, which caused increases in cortisol with greater distance from the cab (Tarrant et al., 1988). Greater distance from the cab also increased the number of weight shifts in animals but not struggles or falls (Tarrant et al., 1992). Behavioral data indicated the increases in bruising were associated with the inability to maintain footing or orient in a preferred direction for maintaining balance due

to high animal numbers, which lead to greater numbers of slips and falls when compared to lower density loads (Tarrant et al., 1988; Tarrant et al., 1992). This is contrary to the hypothesis of Eldridge et al. (1988) that animals at higher densities "held each other up."

Warriss (1990) concluded in his review that duration of transport was a more significant welfare factor than the distance traveled. Camp et al. (1981) concurred with this finding, but longer transport durations in that study also included more animals at higher densities. Longer transport may also subject animals to greater numbers of harsh driving maneuvers. Hard braking and cornering have been attributed to greater bruising in cattle (Tarrant et al., 1988) and sheep (Broom, 2003).

Research in other species specifically related to rest stops indicated that direct transport is better for the overall welfare of the animals even with varying effects of fasting between species. Even though calves transported 24 h showed a greater weight loss than animals fasted for the same period of time (Atkinson, 1992), a separate study indicated that a 1-h rest stop for feeding during a 19-h journey did not seem to significantly decrease weight loss (Knowles et al., 1999). Weight loss up to 15 h in sheep can primarily be attributed to loss of gut fill, and sheep transported 24 h show no greater losses than animals fasted for 24 h (Knowles et al., 1995). Pigs allowed to recover at lairage with feed and water for 6 h after 24 h of transport also showed no improvement in hot carcass weight over pigs that were not rested before being slaughtered (Brown et al., 1999).

Additionally, the importance of stopping for rest is decreased by the willingness, particularly of calves and lambs, to lie down during transport if given room (Cockram et al., 1996). Sheep in particular will increase the time spent lying down during transport

after 5 to 10 h (Knowles, 1998). Cockram et al. (1996) concluded that neither 3 h nor 12 h of lairage during a 24-h journey had an effect on lying behavior of sheep during the remainder of transport or the first 12 h post-transport, and direct transport was better if the animals were given room to lie down. Cattle will begin to lie down after 16 h of transport (Knowles, 1999) as will pigs (Brown et al., 1999).

One advantage to direct transport is the minimization of aggression between animals. Warriss (1990) hypothesized that aggression increased when the vehicle was stopped due to the alleviation of pressures to maintain balance. This is supported by Tarrant (1990) showing decreased aggression when cattle were moved from paddocks to confinement on a truck and a further decrease when the truck began moving. Density in cattle has also been shown to affect aggression with lower densities resulting in increased aggression, but it was not considered a "serious" welfare problem overall, and higher densities were thought to be more counterproductive (Tarrant et al., 1988). In contrast, Knowles et al. (1998) found the effects of high density (0.613 m^2/100 kg) in sheep to be minimal compared to the general effects of transport.

Time needed for recovery from transport is an important factor in determining the necessary length of rest stops. After 14 h of transport in sheep, live weight is recovered and metabolites stabilized after 4 d, but 6 d are needed for full recovery, as measured by creatine kinase (Knowles, 1998). Knowles (1998) also indicated at least 8 h of rest are needed for any real benefit after a 14 h journey. Krawczel et al. (unpublished data) found significant differences in blood constituents such as glucose and creatine kinase after 14 h of transport, at which time sheep also appeared fatigued and approached 10% weight loss. Based on these findings, a 6 h rest stop after 12 h of transport was suggested for

sheep. Pigs need 2 to 3 h of recovery from only 2 h of transport (Warriss et al., 1992). Such lengthy stops would be impractical to conduct onboard a semi-trailer. Proposed guidelines from the European Commission (2002) allow for the resting of animals onboard trailers with the requirements of access to feed and water, adequate ventilation, and lower density, but no clear definition of any of these parameters or necessary length of onboard rest is given.

Only in the past 10 years have similar issues in commercial transport of horses begun to be assessed, likely resulting from public concern for horses sold to slaughter. Research on the transport of group-transported horses has addressed issues of dehydration (Friend, 2000), density (Collins et al., 2000; Stull, 2001; Whiting, 1999) and watering (Gibbs and Friend, 2000) of horses.

Consideration of the size of horses being transported should be given when determining loading density, with larger horses being given more room (Whiting 1999). Similar to findings in sheep and cattle, higher densities increased the number of falls and severity of injuries during transport (Collins et al., 2000). Stull (1999) disagreed based on findings of greater injuries in lower densities, and later suggested that optimum loading density was dependent upon road conditions, weather, driving maneuvers, and compatibility of horses (Stull, 2001). Neither study indicated the effect of density during rest. It has been speculated that a significant amount of aggression in groups of unfamiliar horses can be attributed to one horse (Grandin et al., 1999) regardless of density (unpublished data). Gibbs and Friend (2000) showed a willingness of horses to drink from onboard water troughs, but also that higher densities limit access of some horses to water.

The focus of this paper is on factors affecting the ability of horses to rest onboard a semi-trailer while in transport to slaughter. Currently in the U.S., the maximum allowable duration of transport is 28 h before a mandatory off-loaded rest of 6 h with food and water is required (USDA Veterinary Services, 2002). New regulations for rest stops, feeding, and provision of water are being considered in both the U.S. and the European Union, but little research has been done on the effectiveness of such stops (Table 1). A European Commission report cites the lack of data related to frequency and duration of rest for long-distance travel (considered as any length greater than 8 h), but suggests overnight stops after 6 to 10 h of transport based on the unsubstantiated claim that welfare "becomes considerably worse after 8 to 12 hours of transport" (European Commission, 2002). These recommendations are generally tailored to the transport of sporting horses and the perceptions of their owners. Research has indicated that dehydration and fatigue do not become significant until 28 h in healthy horses (Friend, 2000), which is consistent with findings that feral horses consume water only once a day (Fiest and McCullough, 1976). Transports of longer duration may be additionally stressful for the nearly 8% of slaughter horses with severe welfare problems prior to transport (Grandin et al., 1999), 16% of horses considered geriatric (over 20 years of age), and 28% with obvious unsoundness (McGee et al., 2001).

Table 1. Regulations for transportation of group-transported horses in the United States, European Union, and Canada (USDA Veterinary Services, 2002; European Commission, 2005; CARC, 2001).

Country	Transport duration	Rest stops	Loading density
United States	Up to 28 h	Unloaded for 6 h with food and water	Non-specific
European Union	Up to 24 h, watered every 8 h	Unloaded for 24 h with food and water	1.75 m^2
Canada	Up to 24 h	None Specified	400 kg/m^2 for 450 kg horses

It is of interest to determine if brief periods of onboard rest will benefit horses during long-duration transports. It is possible that horses may be transported for longer periods of time before unloading is necessary if loaded at lower density and provided onboard rest with access to water. Avoiding unloading may be useful because it is generally considered one of the most stressful parts of transport (Grandin, 1997) and has been shown to cause the greatest increase in heart rate of the activities related to transport, even in horses accustomed to humans and transport (Waran and Cuddeford, 1995). One recent study has assessed the relation of rest stop duration to disease susceptibility in performance horses, indicating longer and more frequent rest stops are most beneficial (Oikawa et al., 2005). Rest stops for horses in transit to slaughter facilities have not been evaluated.

Objectives

The issue of rest stops for horses in transport to slaughter will be examined. Factors, such as density, water, and duration of rest stops will be evaluated. The use of video data and direct observation of rest behavior of horses on board a tractor trailer will help determine reasonable length of rest stops and duration of transport between resting.

EXPERIMENT ONE

Video collected during five shipments of slaughter horses in the summer of 2004 was analyzed. The effects of density, water, and order of rest stops on activity of transported horses were examined. It was hypothesized that horses would be very active initially during onboard rest stops followed by a period of low activity while horses rested. Activity would then increase once horses had adequate rest.

Materials and Methods

A 16.2 m x 2.4 m x 2.6 m, single-deck semi-trailer (Barrett Trailers, Purcell, Oklahoma) separated into three compartments (two measuring 5.2 m x 2.44 m, and one 5.5 m x 2.44 m) was fitted with twelve Capture® 1/3" video cameras (Richardson Electronics, Houston, Texas). One camera was mounted in each corner of each compartment near the ceiling. Video data was stored on a four or ten-channel multiplexer (GE Interlogix Kalatel Divison, Corvallis, Oregon) recording device stowed in a compartment beneath the trailer. The multiplexers were cushioned from vibration using bicycle tire inner tubes as an air suspension system. The compartment was ventilated with a fan and filtered air to prevent overheating of the equipment.

Conforming to industry practice, plywood lined the bottom 1.46 m of the interior of the trailer to minimize the possibility of horses catching their feet on the sides of the trailer or damaging the trailer if they kicked. Flooring consisted of a "five-bar tread plates" patterned aluminum crimped every 42 cm to create 2-cm high triangles running the length of the trailer. Ventilation in the horse compartment consisted of two, 15.24-cm wide air gaps that ran the length of each side of the trailer starting at 1.83 m above the

deck of the trailer and eight, 22.9 cm x 8.9 cm roof vents spaced evenly down the center of the trailer. External temperature and humidity were measured in each compartment for the entirety of the trip and rest stops using four HOBO temperature data loggers (Onset Computer, Bourne, MA). A HOBO was placed near the floor of the middle and rear compartments, and a HOBO was mounted near the roof of the rear and front compartments. HOBOs near the roof measured temperature inside and outside of the trailer. All HOBOs recorded similar temperatures, and beginning and ending temperatures for each rest stop were averaged (Appendix B).

The trailer had an onboard watering system as described in Iacono (2005), which consisted of two, 550-L tanks mounted under the trailer that supplied water to float-valve water bowls (Lister SB NT 100, Syrvet, Inc., Waukee, Iowa). Briefly, three water bowls were inserted through ports on each side of the compartment and connected to the watering system via quick-connect fittings at the beginning of each rest stop. Water could be supplied selectively or to all three compartments at once. Water bowls were then removed at the end of each stop.

Video collected during five shipments of slaughter horses in the summer of 2004 was analyzed on a personal computer using Wave Reader 2.9 (GE Security, Corvallis, Oregon). Four trips were conducted between Hudson, Colorado and Dallas/Ft. Worth, Texas, and one trip from La Grande, Oregon to Hudson, Colorado. Some of the horses transported from Oregon to Colorado were later transported to Texas. An additional shipment between Hudson, Colorado and Dallas/Ft. Worth, Texas occurred, but data could not be collected due to a malfunction of the video equipment.

Each shipment consisted of a high (397.44 kg/m^2), medium (348.48 kg/m^2), and low (220.91 kg/m^2) density group, with the high density being similar to the maximum density recommended in the codes for transport of horses in Canada (CARC, 2001). The trips lasted 16 to 20 h with a 1-h rest stop after 8 h and a second rest stop prior to unloading. Although these horses were unloaded immediately after the second rest stop, behavior during the rest stop would apply to commercial conditions where the horses could be hauled for an additional 8 hours. For each shipment, two of the three density groups received water at each rest stop. The density of the groups with access to water varied between trips.

Horses were weighed before and after transport, and a large number was painted on the back of each horse with a livestock grease paint marker prior to loading for identification on video. Movement was quantified by counting the number of times each horse's head crossed the vertical and/or horizontal axes of its body at the withers for each 5-min interval of the 1-h stop.

Several other methods of quantifying movement were initially attempted. Two techniques for tracing the path of head movement were unable to account for differences of scale due to perspective issues arising from camera locations and angles. Obstruction of one horse by another also limited this technique in determining the path of movement. A sampling technique counting number of horses with their heads above the withers was attempted to differentiate between horses that were resting and not; however, some horses rested with their heads above the withers making the data not representative of actual events.

Statistics

Because of the influence of each horse's behavior on the others in the compartment, the experimental unit was the group. Due to the low number of groups in some treatments (Appendix C), high variation within groups, and lack of a truly balanced design, descriptive statistics were used. Mean number of movements per horse visible in each compartment was calculated across each 5-min interval (SPSS, 2003), and compartments in the same treatments (density and water) were averaged. Comparisons were made between densities, first and second stops, and access to water.

Results

High Density

There was a striking difference in amount of head movement between watered and non-watered high-density groups (Figure 1). The high-density groups that were offered water were much more active at the start of both rest stops. Activity for the watered groups approached basal levels after 10 min except for a resurgence of activity at 20 min for the first stop. The non-watered, high-density groups maintained a relatively consistent, lower level of activity (Figure 1). There was an increase in activity at the end of the first stop for the non-watered groups.

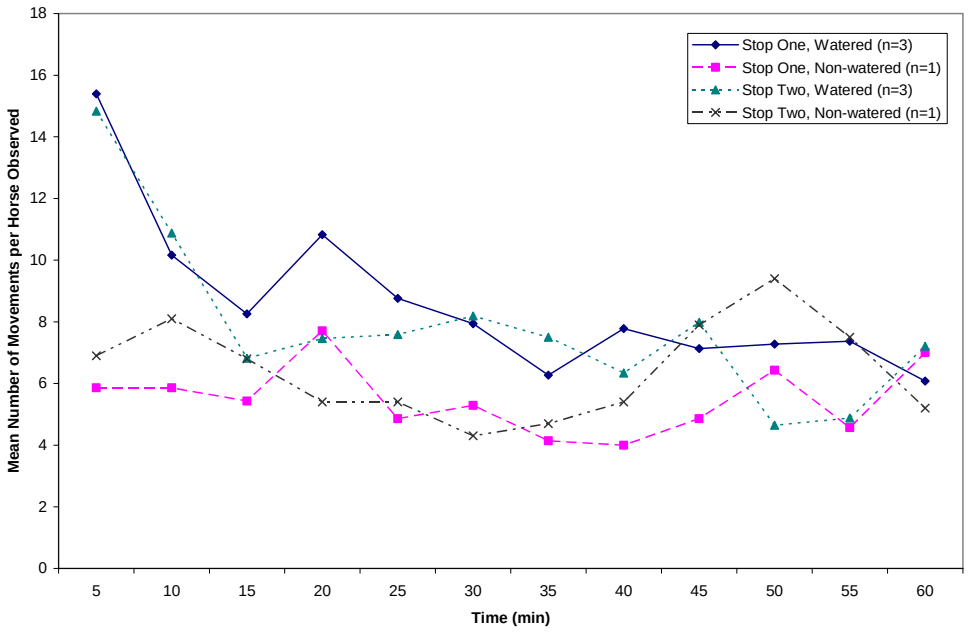

Figure 1. Activity (mean number of movements per horse observed) of high-density groups averaged across 5-min intervals during 1-h rest stops.

Medium Density

The watered groups during the second stop showed the greatest amount of initial activity. A moderate level of initial activity was seen for both the watered and non-watered groups at stop one, and no initial peak occurred for the non-watered group at stop two (Figure 2). All medium-density groups showed an increase in activity at 55 min, possibly indicating the end of a rest cycle.

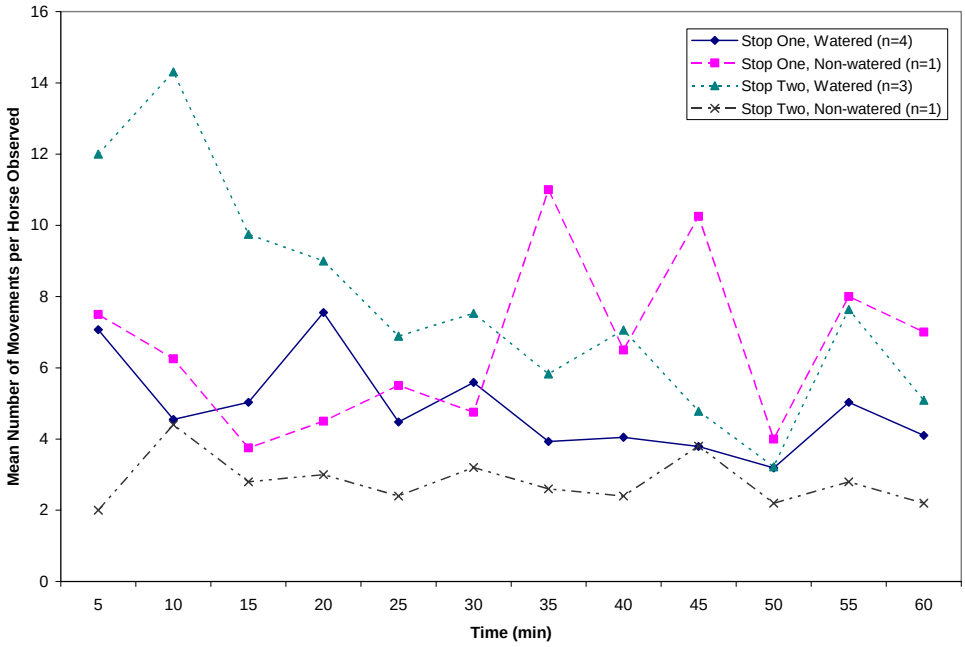

Figure 2. Activity (mean number of movements per horse observed) of medium-density groups averaged across 5-min intervals during 1-h rest stops.

Low Density

The watered groups in the low-density treatment (Figure 3) were especially active the first 10 min of the first rest stop; however, this should be evaluated with care given low number of groups in the treatment (Figure 3). There was a slight trend for the watered groups to show increased activity during the first 25 min of the second rest stop. There was also a slight trend to increase activity after 55 min of the stop for three of the low-density treatment groups.

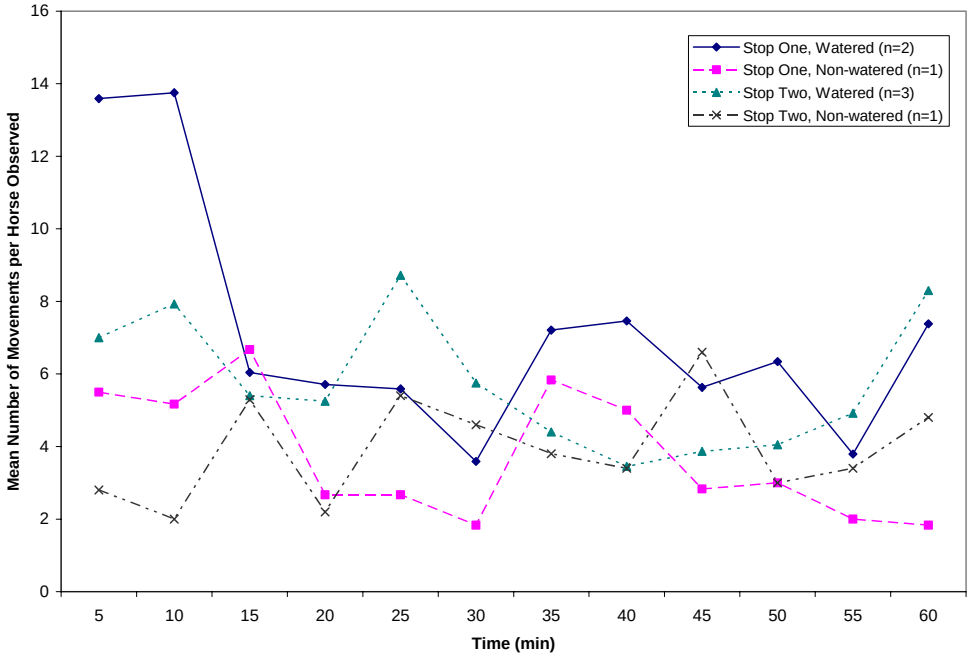

Figure 3. Activity (mean number of movements per horse observed) of low-density groups averaged across 5-min intervals during 1-h rest stops.

Discussion

Watered groups showed greater movement at the beginning of a stop as horses maneuvered for access to water; however, activity became similar to that of the non-watered groups after 15 to 25 min, depending on density. This is similar to the time it takes for most horses to drink from onboard watering troughs in hot weather (Gibbs and Friend, 2000). In cooler weather, horses can take up to an hour before they first drink (unpublished data). Temperatures ranged from 21 to 24°C, 22 to 29°C, 28 to 32°C, and 29 to 32°C during the first rest stops of Shipments One, Three, Four, and Five, respectively. Temperatures at the second rest stops of each shipment ranged from 18 to 24°C, 28 to 34°C, 25 to 38°C, 29 to 38°C, and 29 to 36°C. The initial activity may have been associated with the placement of water bowls into the trailer, maneuvering for

access, or aggression between horses over water. The resurgence of activity in the high density at 20 min may have been due to horses repositioning themselves after the first horses to drink finished drinking.

While it would be expected that horses would be more fatigued at the second stop, no consistent difference was seen between rest stops. The similar activity between watered and non-watered medium-density groups for the first stop may be due to the horses being less fatigued, but a similar trend did not occur in the other densities. Previous research indicated horses can be transported for longer periods when water is available at rest stops (Friend, 2000). Perhaps access to water minimizes the effect of fatigue during the transport, but the low number of non-watered groups in this study makes comparisons difficult. Both medium and low-density groups showed a slight increase in activity after 55 min indicating 1-h rest stops may be adequate at the lower densities, but additional research is needed to further evaluate the return to activity seen at the end of the stops as an indication of sufficient rest.

While some groups showed increased initial activity as expected, no clear trend of lower activity during the stop or increased activity at the end of the stop was seen. Data should be interpreted with caution due to high variability in the data and low number of groups in each treatment (Appendix C). The differences were more apparent between watered and non-watered horses as compared to differences between densities. Increases in activity at the end of the stop were only moderate, potentially indicating stops should be longer in order to see if activity would increase more dramatically once horses have rested.

EXPERIMENT TWO

This experiment was conducted to further examine the usefulness of onboard rest stops for horses in transport to slaughter. The variables of density and water were eliminated and the duration of the rest stop was increased to more critically evaluate the effect of onboard rest stops on activity of horses. Direct observation was utilized to collect information on the causal factors associated with activity in the compartments as well as to avoid the loss of data due to technical problems with the video equipment. It was hypothesized that a trend similar to that expected the previous year would be seen in which horses would be initially active when movement of the trailer first ceased, decrease activity for a period of time, and resume higher levels of activity after recovery.

Materials and Methods

Data were collected during two shipments of slaughter horses in the summer of 2005 between Hudson, Colorado and Dallas/Ft. Worth, Texas. The same trailer was used as in Experiment One, but the watering system was not used for these trips. Horses were of various breeds, ages, sexes, and body conditions, and time of commingling varied between animals. All horses were loaded at an average density of 397.32 kg/m^2, similar to the maximum density allowed under recommended codes for transport in Canada (CARC, 2001). The first shipment lasted 22 h and 15 min, and the second shipment lasted 23 h and 45 min. Ninety-minute rest stops were conducted after every 6 h of transport and prior to unloading. Temperature and humidity were measured in each compartment for the entirety of the trip and rest stops using three HOBO temperature data loggers (Onset Computer, Bourne, MA). HOBOs were placed near the floor in each

compartment. Temperatures recorded on all HOBOs were similar. Beginning and ending temperatures from all HOBOs at each rest stop were averaged. Each horse was weighed prior to loading and again after arrival at the slaughter facility.

Data were collected by investigators on extension ladders placed against the side of the trailer at each rest stop. An overhead view of the horses could be obtained through the 15.24-cm air gaps at the top of the trailer. One investigator per compartment recorded the number of horses standing alert, resting, moving, and indiscernible at each 1-min interval of the rest stop (Appendix A). Standing alert was defined as a horse being still but alert, with ears raised, eyes open, or head up. Resting included horses with heads lowered, eyes slightly open, ears slack, or hips tilted from resting one hind leg. Moving was any time a horse's head or body was in motion. Horses may not have exhibited all elements of a particular category due to limitations from density, but classifications were made based on the behavior for which a horse met the most criteria. Observers also recorded notes indicating aggression and other outside influences that may have affected resting. For the final analysis, counts for standing alert and moving were combined to constitute 'active.'

To ensure reliability of counts, behaviors were defined for all observers and examples given at the slaughter-buyer's facility. The observers were then asked to categorize horses in paddocks on the premises as an informal test. A total of four observers were used for both trips, and each observer watched the same compartment at each stop. Two of the three observers for each shipment were present for both Shipments One and Two providing some level of consistency.

Statistics

The compartment was used as the experimental unit to account for interactions between horses. However, data should be interpreted with caution due to the effects of actions in one compartment stimulating horses to be alert in other compartments, as noted by observers. Due to the low number of groups and the high variation within groups (Appendix C), descriptive statistics were used. Percentage of visible horses considered 'active' at each minute was determined. Mean percentage for each 5-min interval of the 90-min stop was calculated (SPSS, 2003) and graphed in order to characterize changes in activity over the rest stop. Increases greater than 15% were considered peaks of activity. Ten of the eleven peaks discussed occurred within a 5-min interval. The additional peak increased approximately 25% in five minutes but continued to rise slightly for the next five minutes as well.

Results

Shipment One

Shipment One lasted 22 h 15 min with 90-min rest stops at 2045, 0415, and 1130. Temperatures inside the trailer ranged from 27 to 30°C, 24 to 26°C, and 32 to 36°C for stops one, two, and three, respectively (Appendix B). The average change in temperature across all three stops was 3°C, with temperature steadily decreasing during stop one, fluctuating during stop two, and rising consistently during stop three. The increase in temperature at stop three was likely due to increasing ambient temperatures in the late morning and early afternoon hours. Average weight loss for this shipment was 7%.

Activity varied greatly between compartments (Table 2). Activity markedly increased at the beginning of the first rest stop and then subsided at 20 min (Figure 4). The resurgence of activity at 25 min could be attributed to aggression noted by the observer of one compartment, which then caused more horses to become alert in the other two compartments. However, the increased activity at 55 min occurred in two compartments and was not noted by any of the observers to result from aggression or outside stimuli (e.g. other trucks, machines, voices). Activity at the beginning of the second rest stop was markedly less than the first rest stop until 30 min. Subsequent peaks occurred at 50 min and 70 min for two of the compartments, but neither peak was directly noted by any of the observers as resulting from aggression. Activity at the third rest stop was less than stop one but greater than stop two for the initial 25 min. The peaks at 45 min and 70 min can both be ascribed to aggression in a specific compartment arousing horses in the entire trailer.

Table 2. Mean percentage of horses active during 90-min rest stops for Shipment One.

Stop	Compartment one	Compartment two	Compartment three	Combined average
1	37.75 ± 6	48.03 ± 4.76	30.73 ± 5.6	38.84 ± 3.25
2	14.65 ± 2.64	30.81 ± 2.98	19.71 ± 3.21	21.72 ± 1.91
3	30.30 ± 4	37.03 ± 3.74	20.46 ± 2.46	29.26 ± 2.18

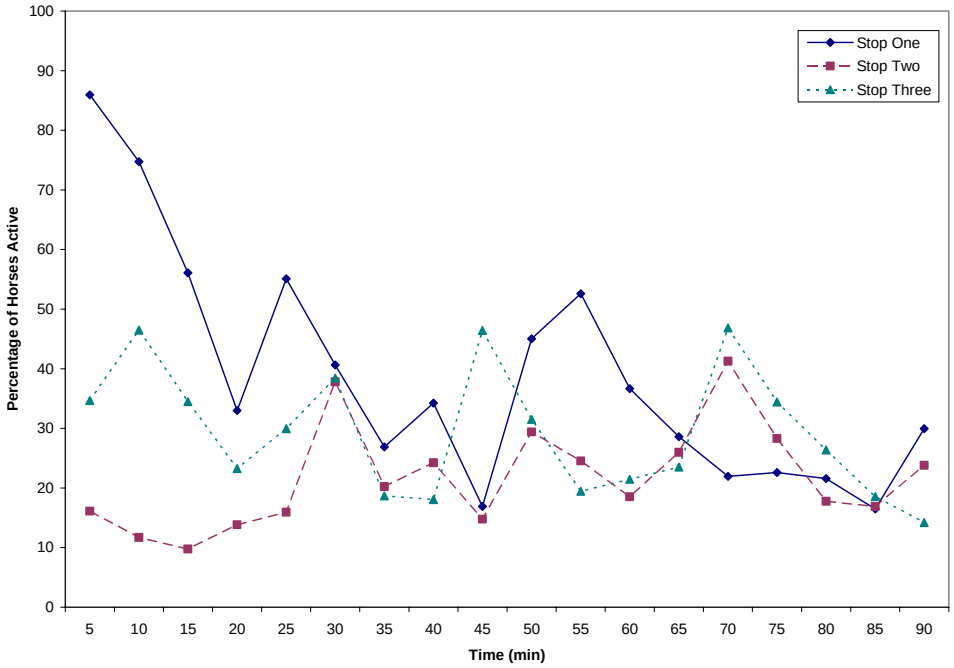

Figure 4. Activity (percentage of horses active) across 5-min intervals during 90-min rest stops for Shipment One.

Shipment Two

Shipment Two lasted 23 h 45 min with rest stops at 1915, 0315, and 1045. Temperatures measured inside the trailer ranged from 34 to 35°C, 27 to 28°C, and 31 to 36°C for stops one, two, and three, respectively (Appendix B). Temperatures fluctuated during stops one and two and rose continuously during stop three as ambient temperatures increased. The mean temperature change was 3°C. Average weight loss was 6.75% for this shipment.

Activity varied greatly between compartments, with compartment two having less activity at all three stops (Table 3). All three stops had a heightened level of activity initially, but the difference was not as dramatic as in Shipment One (Figure 5). Activity during stop one became steadier after 35 min. Activity decreased at 55 min and rose again at 60 min due to aggression that aroused horses in all three compartments. No

possible cause was noted to account for the increase at 85 min. At stop two, activity decreased sharply between 5 and 15 min, and continued to decrease until 25 min. Activity then peaked at 55 min due to aggression in one compartment and reactions of horses in other compartments to the commotion. Activity increased consistently after 75 min. Initially this activity is attributable to aggression noted in a compartment, but activity remained high for the rest of the stop, even after aggressive acts were no longer seen. One horse in particular was noted to instigate aggression in a compartment beginning at 25 min. Initially this behavior was directed at one other horse and gradually more horses were bitten. Activity at stop three was elevated between 35 and 45 min after a bout of aggression in one compartment stimulated alertness in another compartment, and peaked again at 55 min without any associated cause.

Table 3. Mean percentage of horses active during 90-min rest stops for Shipment Two.

Stop	Compartment one	Compartment two	Compartment three	Combined average
1	52.24 ± 2.42	27.84 ± 2.89	59.29 ± 2.93	46.46 ± 2.42
2	63.49 ± 2.68	41.37 ± 3.74	62.13 ± 6.64	55.67 ± 2.98
3	62.73 ± 2.18	38.70 ± 4.53	45.05 ± 4.22	48.83 ± 2.56

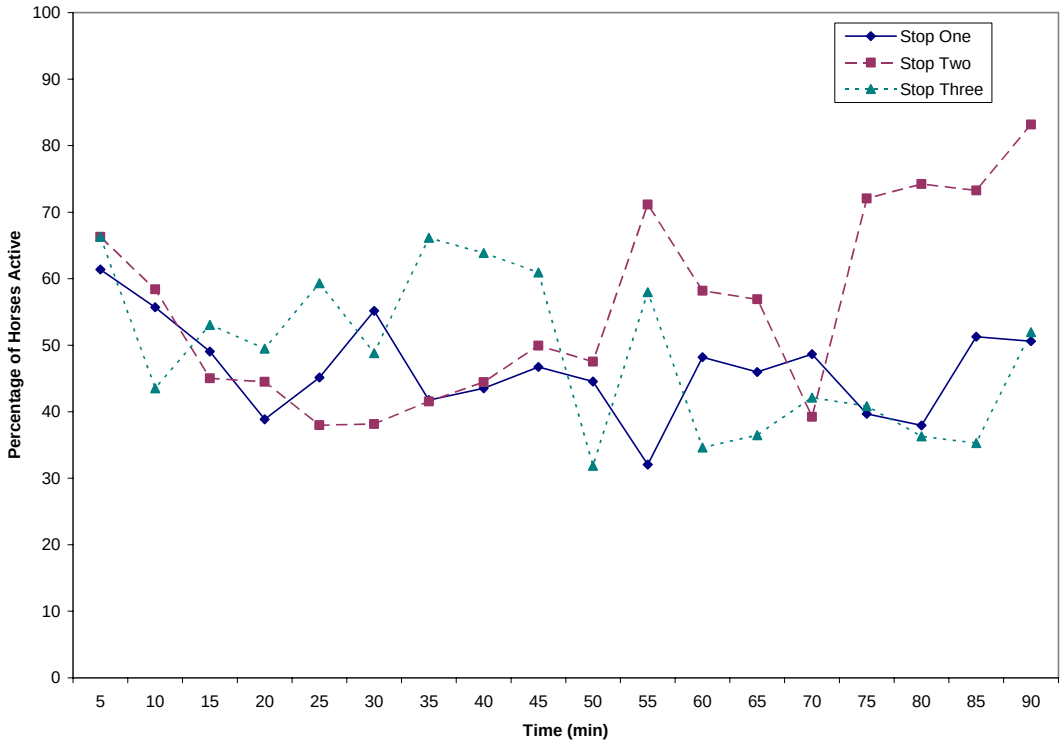

Figure 5. Activity (percentage of horses active) across 5-min intervals during 90-min rest stops for Shipment Two.

Discussion

A trend for high initial activity at the beginning of rest stops was seen in stops one and three of Shipment One and more moderately in all three stops of Shipment Two. This activity then decreased by 20 min for stops in Shipment One and two of the three stops in Shipment Two. Occasionally, sharp peaks interrupted the periods of lower activity. Some of the peaks could be associated with aggression in a compartment, but others were due to general commotion in the trailer such as changing positions. Observations indicated that commotion in one compartment would oftentimes arouse horses in the neighboring compartment and sometimes the entire trailer. Aggressive acts were noted in 23 of the 5-min intervals. Of these, 14 caused secondary reactions in at least one other compartment. These reactions were not necessarily dramatic, but horses

were aroused at least to the point of standing alert, which was included in the ‘active’ category.

Curtis (1983) defines the effective environmental temperature as the temperature the animal experiences after additional environmental factors such as humidity and wind velocity are accounted for, and indicates rises in temperatures that result in an effective environmental temperature greater than 5°C above an animal’s normal body temperature can cause severe distress. Temperatures at rest stops for both trips ranged from 24°C to 36°C with relative humidity ranging from 22 to 40%. These temperatures did not exceed the normal rectal temperature of horses, and humidity was not over 50%, the threshold at which it is considered to increase the effects of high temperatures (Curtis, 1983). Additionally, higher temperatures have been shown to result in less activity in Przewalski horses in a 44 ha semi-natural enclosure (Berger et al., 1999); whereas in this study, the greatest temperatures were recorded at stop three, but activity was similar to the previous stops, except for initially in Shipment One and between 35 and 45 min of Shipment Two. Temperature and humidity are not considered to have affected activity for this study.

While a slight trend for high initial activity was seen as hypothesized, particularly in Shipment One, no consistent trend was observed for all of the rest stops. Groups did not consistently decrease activity within individual stops or between stops, and also did not show a strong trend of increased activity near the end of a stop that would indicate they had adequately rested. Patterns may not have been seen due to horses not being transported long enough to be fatigued or because of high variability within the data due to factors such as aggression and outside stimuli.

GENERAL DISCUSSION

The rest stops in these studies were conducted without unloading the horses. Few facilities are available for the resting of horses in transport to slaughter, and it is generally accepted that the most stressful portion of a trip is the loading and unloading process, e.g. calves (Trunkfield and Broom, 1990) and sheep (Knowles cited in Grandin, 1997). An increase in injuries has also been associated with repeated loading and unloading (Irwin and Gentleman, 1978; Reece et al., 2000). Krawczel et al. (unpublished data) disagreed based on findings that loading and unloading sheep three times presented no difficulty or increased injury, but it should be noted the sheep were hand fed to tame them and the sheep were not crowded. Previous studies evaluating onboard rest during the transport of sporting horses indicated longer rest periods were more beneficial in reducing serum glucose concentrations and peripheral eosinophil numbers (Oikawa et al., 2005). Factors such as travel time (4 h between 2h stops) and type of horses used in that study are not representative of conditions during transport to slaughter.

Usefulness of rest stops is still under debate, and industry perspectives may be correct in that quicker arrival at facilities may be better for the overall health of the animals. Grandin (1997) cites production experience indicating fewer health problems in weaned calves transported 32 h without rest; however, in that study ‘rest’ involved unloading the calves. As mentioned in the introduction, it is also possible that direct transport may only be beneficial for animals which are willing to lie down while in transit and are better able to withstand the effects of fasting. Horses are generally considered unwilling to lie down during transport, as supported by research on horses transported 24

h (Stull and Rodiek, 2000) and up to 27 h (Friend, 2000) which were not indicated to have lain down during the studies.

Previous studies have indicated that temperatures within a trailer rise rapidly once movement stops (Fisher et al., 2004; Knowles et al., 1995). The stops in Knowles et al. (1995) occurred between 2400 and 0200, at which time the trailer was onboard a ferry. Temperatures also increased as ambient temperatures rose (Knowles et al., 1995). Fisher et al. (2004) found an increase in temperature-humidity index during stationary periods with ambient conditions, initial temperature, and length of the stop contributing to the increases. Temperature increases in the current experiment were primarily seen during stops in the late morning and early afternoon hours when ambient temperatures were also rising (Appendix B). Temperatures rose an average of 8.2°C for the second stops in Experiment One, and only 3.75°C on average during the first stops. These stops occurred during the late night and early morning hours, and temperature increases were likely due to the build up of heat generated from the horses. In Experiment Two, temperatures steadily declined or fluctuated within a range of 3°C for the first two stops of both trips. Temperatures did steadily increase during the third stop of both trips changing by 5 to 6°C as ambient temperatures were also rising in the late morning and early afternoon hours, but critical temperatures were not reached. Activity did not differ greatly between stops, even when temperatures were higher. Generally horses will decrease activity in hotter weather (Berger et al., 1999). The lack of difference between stops seems to indicate that temperature did not have an effect.

While no obvious or consistent change in activity occured, it does not seem that rest stops longer than 1 h provide any additional benefit. In both experiments several

compartments showed a peak of activity between 50 and 60 min**,** which may indicate animals have recovered adequately to continue the journey. This finding is consistent with that of cattle, which slept in bouts of 1 h or less even after transport of various lengths up to and exceeding 280 miles, and mean number sleeping (eyes closed) or recumbent decreased after 1 h of lairage (Atkinson, 1992).

One hour of rest should also allow for horses to achieve normal amounts of slow wave sleep. Sleep has been characterized in horses as consisting of sleep phases ranging from 30 to 40 min totaling 3 to 5 h per day (Dallaire, 1986). Particularly older horses can achieve much of their resting needs in a state of drowsiness, which Dallaire defined similarly to how 'resting' was defined in Experiment Two, but are easily aroused from any stage of sleep (Dallaire, 1986). This could explain the increase in activity in other compartments following aggression in a single compartment.

A weak trend for sleep cycles could be seen within the data for both experiments, but interpretation should be done with caution. Periods of decreased activity could be seen ranging from 20 to 30 min, e.g. Figure 4, Stop Three, 45 to 70 min; however, other similar periods in the data had interruptions, e.g. Figure 4, Stop One, 25 to 55 min. The interruptions could most often be corroborated with the observer's reports of aggression in the compartment, but other causes of unrest were due to noises such as five instances of other semi trucks driving by or pulling beside the trailer, one instance of machines in the vicinity turning on or off, and two instances of people talking outside the trailer. The majority of peaks of activity coincided with bouts of aggression noted by the observers. This may be due to aggressive horses having rested and beginning to instigate fights. While some aggression will likely always occur, 1 h of rest should allow some groups of

horses time to settle once the trailer has stopped moving and complete a period of slow-wave sleep or drowsiness. Studies using heart rate or respiration rate could be useful in supporting these claims.

Rest behavior is also dependent on time of day. Horses tend to nap in the hot afternoon hours and sleep between 2000 and 0500 (Dallaire, 1986). This may account for the horses not resting as much at rest stops before 2000, resting more at stops in the early morning hours, especially after being deprived of sleep for most of the normal resting time, and being more active at the last stop in late morning to early afternoon for Experiment Two. Travel beginning earlier in the day and lasting through daylight hours when horses are normally awake may prove to be less stressful and less disruptive to normal sleep patterns.

Density seems to have played a role in activity of the horses in the first experiment. High density groups showed a marginally higher level of basal activity compared to medium and low-density groups. This high density may have occluded the ability of these groups to adequately rest onboard the trailer. Friend (2001) cited the restriction of movement inhibiting natural behavior patterns and the inability of horses to escape more aggressive horses as stressors of high-density transport. This effect may also contribute to fatigue from maintaining unnatural body postures (Waran and Cuddeford, 1995). Collins et al. (2000) proposed that moderate densities would allow horses room to maintain more comfortable positions during transport, possibly to rest during stationary periods, and also avoid aggressive horses in a load. It has been noted in other studies by our lab (Collins et al., 2000) as well as Grandin et al. (1999) that many aggressive acts can originate from one or two horses in a group.

Separation of horses into compartments containing smaller numbers of animals may be beneficial, but is a complex issue. Tarrant et al. (1988) studied the effects of animals at different loading densities in which density was adjusted by manipulating either pen size or number of animals per pen. While no direct conclusions were drawn about the comparative effects of similar densities achieved in this way, lower animal numbers per pen may reduce the probability of an aggressive horse in a compartment or at the very least the number of other horses subject to the aggression. European Union directives also state that untame horses should be loaded in groups of no more than four animals (European Commission, 2005). While many slaughter horses are tame, as defined by their ability to be lead easily by a halter, they are also unfamiliar with each other. However, it is possible that low numbers may inhibit a subordinate animal's attempts to escape. Smaller pen size would limit the available maneuvering space and distance a horse could get from the aggressor. Fewer horses would also mean decrease the number of horses to share the burden of aggressive attacks.

The use of a temperament score similar to that used in Hearnshaw, Barlow, and Want (1979) for separating animals based on aggressiveness would not be applicable to the slaughter horse industry. The temperament score used in that study was based on chute behavior of cattle such as tail swishing, straining, paddling, kicking, kneeling, and jumping. This may not be a good indicator of aggression in horses because some are docile in a chute or when interacting with humans but become aggressive with other horses. Additionally, once a dominant horse is removed another may simply take its place at the top of the hierarchy and continue to attack the others. Time constraints or the

method of acquiring several horses from different auctions may also prevent horses from being sorted based on temperament in order to reduce aggression.

European regulations require that horses, cattle, and sheep be unloaded for a rest stop of 24 h after 24 h of transport (European Commission, 2005). The data from these studies do not indicate any differences in activity at rest stops after 16 to 24 h of transport. Comparable work in sheep indicates that greater than 15 h may be detrimental even with a sheep's ability to withstand weight loss greater than gut fill and ability to rest onboard a trailer in motion (Knowles, et al., 1995). Warriss et al. (1995) also indicated that transports lasting 15 h are not significantly worse than 10 h transports for cattle based on blood composition and behavior, and creatine kinase increases significantly only after 15 h. Additionally, cattle were subjectively characterized as being more docile after 15 h of transport (Warriss et al., 1995). In the current studies, the only measure used that may indicate the animal's state of well being was weight loss, which can indicate dehydration, but blood composition and packed cell volume are more reliable measures (Friend et al., 1998). Weight loss did not appear to be different between years, with 4.5% shrink in Experiment One and 6.9% shrink in Experiment Two, where transports lasted up to 20 h and 23 h, respectively. Previous studies have indicated that horses will not exhibit significant dehydration or fatigue until after 27 h of transport in hot conditions without water (Friend, 2000).

The methods in this study served to measure behavior in as objective terms as possible by relying on quantification of defined behaviors. However, other methods commonly used to evaluate animal welfare and stress should also be considered. Beyond behavior, data for objective analysis can be collected on hormone concentrations,

immune function, and carcass characteristics to further evaluate responses of animals to situations such as transport, which are commonly considered stressful. Unfortunately, for experiments such as these, blood data can only be compared from the beginning to the end of the shipment due to inaccessibility of horses for sampling while on the trailer. If methods could be devised to obtain serial blood samples over the course of the rest stop, such data may help corroborate changes seen in behavior. Comparisons to findings of increased white blood cell counts, hematocrit, lactate concentration, and creatine kinase concentration when horses were transported for 24 h without rest (Stull and Rodiek, 2000) may be useful, but should give careful consideration to differences between methods and external variables such as environment. Immunological challenge tests requiring blood sampling and inoculation over two weeks are also not practical because of the short time span in which slaughter horses are gathered and transported, but more direct observations of carcass scores and more thorough assessment of injuries in conjunction with video or behavioral data may provide indicators of effects of rest during transport.

There are also limitations to data from blood collection such as natural diurnal changes in some hormone concentrations (Broom, 2003). Physiological data also cannot always distinguish between stimuli. Some physiological changes appear the same to both appetitive and aversive stimuli, and can require behavioral observation to make a distinction (von Borell, 2001; Waran, 1993). Additionally, physiological data presents an objective analysis of numerical changes in values, but determination of values which indicate acceptable and unacceptable welfare must still be determined within variable moral and ethical frameworks (Adams, 1994).

Comparative analysis of behavior can also be beneficial in accounting for variability due to individual past experiences, coping mechanisms, or genetics (Broom, 2003). Observing animals under pasture conditions or confinement conditions when not being transported could provide baseline data for comparison to data collected under experimental conditions. In the current study, collection of baseline data would have been infeasible due to the methods used by the slaughter-buyer to collect and house the horses as well as limitations of the slaughter-buyer's facilities.

CONCLUSION

Activity was highly variable, many spikes were likely due to aggressive encounters in compartments keeping other horses alert. There were no consistent changes in activity over rest stops lasting either 60 min or 90 min. High-density groups remained slightly more active than medium and low-density groups in Experiment One, making the medium density (348.48 kg/m^2) appear to be more optimal for minimizing activity. Provision of water increased activity at the beginning of rest stops, but activity then decreased and became similar to non-watered horses. Providing water may reduce dehydration and facilitate horses in maintaining normal body temperatures, but previous research indicates dehydration is not significant until 28 h (Friend, 2000). Due to the variability of the data, it is not clear whether rest stops are efficacious during transports of 24 h duration or less or how long horses should be allowed to rest. These data provide no indication of differences in activity during rest stops for up to 24 h of transport, and therefore support the current regulations for this duration. However, speculation cannot be made about differences that may occur after 24 h of transport.

LITERATURE CITED

Adams, D. B. 1994. Transportation of animals and welfare. Rev. Sci. Tech. 13:153-169.

Atkinson, P. J. 1992. Investigation of the effects of transport and lairage on hydration state and resting behavior of calves for export. Vet. Rec. 130:413-416.

Berger, A., K. Scheibe, K. Eichhorn, A. Scheibe, and J. Steich. 1999. Diurnal and ultradian rhythms of behavior in a mare group of Przewalski horse (*Equus feris przewalskii*), measured through one year under semi-reserve conditions. App. Anim. Behav. Sci. 64:1-17.

Broom, D. M. 2003. Transport stress in cattle and sheep with details of physiological, ethological and other indicators. Dtsch. tierarztl. Wschr. 110:83-89.

Brown, S. N., T. G. Knowles,J. E. Edwards, and P. D. Warriss. 1999. Behavioural and physiological responses of pigs to being transported for up to 24 hours followed by 6 hours recovery in lairage. Vet. Rec. 145:421-426.

Camp, T. H., D. G. Stevens, R. A. Stermer, and J. P. Anthony. 1981. Transit factors affecting shrink, shipping fever and subsequent performance of feeder calves. J. Anim. Sci. 52:1219-1224.

CARC. 2001. Recommended code of practice for the care and handling of farm animals. Canadian Agri-Food Research Council, Ottawa, Ontario. p40.

Cockram, M. S., J. E. Kent, N. K. Waran, and P. J. Goddard. 1996. Effects of journey length, space allowance during transport, and lairage during and after road transport on the behavior of sheep. In: Proceedings of the 30th International Congress of the International Society for Applied Ethology, Guelph, Ontario, Canada.

Collins, M. N., T. H. Friend, F. D. Jousan, and S. C. Chen. 2000. Effects of density on displacement, falls, injuries, and orientation during horse transportation. Appl. Anim. Behav. Sci. 67:169-179.

Curtis, S. E. 1983. Environmental Management in Animal Agriculture. Iowa State University Press, Ames, IA.

Dallaire, A. 1986. Rest Behavior. Vet. Clin. North Am. Equine Pract. 2:591-607.

Eldridge, G. A., C. G. Winfield, and D. J. Cahill. 1988. Responses of cattle to different space allowances, pen sizes and road conditions during transport. Aust. J. Exp. Ag. 28:155-159.

European Commission. 2002. The welfare of animals during transport (details for horses, pigs, sheep, and cattle). Report of the Scientific Committee on Animal Health and Animal Welfare, European Commission.

European Commission. 2005. Council regulation (EC) 1/2005. Europa. European Union. Accessed 22 September 2005. http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/oj/2005/l_003/l_00320050105en00010044.pdf

Feist, J. D. and D. R. McCullough. 1976. Behavior patterns and communication in feral horses. Z. Tierpsychol. 41:337-371.

Fisher, A. D., M. Stewart, D. M. Duganzich, J. Tacon, and L. R. Matthews. 2004. The effects of stationary periods and external temperature and humidity on thermal stress conditions within sheep transport vehicles. New Zealand Veterinary Journal. 53:6-9.

Friend, T. H. 2000. Dehydration, stress, and water consumption of horses during long-distance commercial transport. J. Anim. Sci. 78:2568-2580.

Friend, T. H. 2001. Dehydration, stress, and water consumption of horses during long-distance commercial transport. J. Anim. Sci. 78:2568-2580.

Friend, T. H., M. T. Martin, D. D. Householder, and D. M. Bushong. 1998. Stress responses of horses during a long period of transport in a commercial truck. J. Am. Vet. Med. Assoc. 212:838-844.

Gibbs, A. E., and T. H. Friend. 2000. Effect of animal density and trough placement on drinking behavior and dehydration in slaughter horses. J. Eq. Vet. Sci. 20:643-650.

Grandin, T. 1997. Assessment of stress during handling and transport. J. Anim. Sci. 75:249-257.

Grandin, T., K. McGee, and J. L. Lanier. 1999. Prevalence of severe welfare problems in horses that arrive at slaughter plants. J. Am. Vet. Med. Assoc. 214:1531-1533.

Hearnshaw, H., R. Barlow, and G. Want. 1979. Development of temperament and handling difficulty score in cattle. Pages 164-166 in Proceedings of the Inaugural Conference Australian Association of Animal Breeding and Genetics, Armidale, N. S. W. Australia.

Iacono, C. 2005. Effects of density and water availability on the behavior, physiology, and weight loss of slaughter horses during transport. M.S. Thesis, Texas A&M University, College Station.

Irwin, M. R., and W. R. Gentleman. 1978. Transportation of cattle in a railcar containing both feed and water. Southwestern Veterinarian 31:205-208.

Knowles, T. G. 1998. A review of the road transport of slaughter sheep. Vet. Rec. 143:212-219.

Knowles, T. G. 1999. A review of the road transport of cattle. Vet. Rec. 144:197-201.

Knowles, T. G., S. N. Brown, J. E. Edwards, A. J. Phillips, and P. D. Warriss. 1999. Effect on young calves of a one-hour feeding stop during a 19-hour road journey. Vet. Rec. 144:687-692.

Knowles, T. G., S. N. Brown, P. D. Warriss, A. J. Phillips, S. K. Dolan, P. Hunt, J. E. Ford, J. E. Edwards, and P. E. Watkins. 1995. Effects on sheep of transport by road for up to 24 hours. Vet. Rec. 136:431-438.

Knowles, T. G., P. D. Warriss, S. D. Brown, and J. E. Edwards. 1998. Effects of stocking density on lambs being transported by road. Vet. Rec. 142:503-509.

McGee, K., J. L. Lanier, and T. Grandin. 2001. Characterization of horses at auctions and in slaughter plants. J. Anim. Sci. 79(Suppl. 1):17. (Abstr.)

Oikawa, M., S. Hobo, T. Oyamada, and H. Yoshikawa. 2005. Effects of orientation, intermittent rest and vehicle cleaning during transport on development of transport-related respiratory disease in horses. J. Comp. Path. 132:153-168.

Reece, V. P., T. H. Friend, C. H. Stull, T. Grandin, and T. Cordes. 2000. Equine slaughter transport – update on research and regulations. J. Am. Vet. Med. Assoc. 216:1253-1258.

SPSS. 2004. Version 12.0.1. Claritas, Inc. Troy, NY.

Stull, C. L. 1999. Responses of horses to trailer design, duration, and floor area during commercial transportation to slaughter. J. Anim. Sci. 77:2925-2933.

Stull, C. L. 2001. Evolution of the proposed federal slaughter horse transport regulations. J. Anim. Sci. 79(E. Suppl.):E12-E15.

Stull, C. L. and A. V. Rodiek. 2000. Physiological responses of horses to 24 hours of transport using a commercial van during summer conditions. J. Anim. Sci. 78:1458-1466.

Tarrant, P. V. 1990. Transportation of cattle by road. Appl. Anim. Behav. Sci. 28:153-170.

Tarrant, P. V., F. J. Kenny, and D. Harrington. 1988. The effect of stocking density during 4 hour transport to slaughter on behavior, blood constituents and carcass bruising in Fresian steers. Meat Sci. 24:209-222.

Tarrant, P. V., F. J. Kenny, D. Harrington, and M. Murphy. 1992. Long distance transportation of steers to slaughter: Effect of stocking density on physiology, behavior and carcass quality. Livest. Prod. Sci. 30:223-238.

Trunkfield, H. R., and D. M. Broom. 1990. Welfare of calves during handling and transport. Appl. Anim. Behav. Sci. 28:135-152.

USDA. 1999. Livestock slaughter 1998 summary. National Agricultural Statistics Services. Washington, DC. Accessed 26 September 2005. http://usda.mannlib.cornell.edu/reports/nassr/livestock/pls-bban/lsan0399.txt

USDA. 2005. Livestock slaughter 2004 summary. National Agricultural Statistics Services. Washington, DC. Accessed 26 September 2005. http://usda.mannlib.cornell.edu/reports/nassr/livestock/pls-bban/lsan0305.txt

USDA Veterinary Services. 2002. Guidebook for USDA's slaughter horse transport program. United States Department of Agriculture, Animal and Plant Health Inspection Service, Washington, DC, USA. pp. 37-38.

Von Borell, E. H. 2001. The biology of stress and its application to livestock housing and transportation assessment. J. Anim. Sci. 79 (E. Suppl.):E260-E267.

Waran, N. K. 1993. The behaviour of horses during and after transport by road. Equine Vet. Educ. 5:129-132.

Waran, N. K., and D. Cuddeford. 1995. Effects of loading and transport on the heart rate and behavior of horses. Appl. Anim. Behav. Sci. 43:71-81.

Warriss, P. D. 1990. The handling of cattle pre-slaughter and its effects on carcass and meat quality. Appl. Anim. Behav. Sci. 28:171-186.

Warriss, P. D., S. N. Brown, J. E. Edwards, M. H. Anil, and D. P. Fordham. 1992. Vet. Rec. 131:194-196.

Warris, P. D., S. N. Brown, T. G. Knowles, S. C. Kestin, J. E. Edwards, S. K. Dolan, and A. J. Phillips. 1995. Effects on cattle of transport by road for up to 15 hours. Vet. Rec. 136:319-323.

Whiting, T. 1999. Maximum loading density of loose horses. Can. J. Anim. Sci. 79:115-118.

APPENDIX A

Table A1. Number of horses alert at each minute of stop one of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	9	11	10	30
2	10	10	10	30
3	6	7	7	20
4	10	8	6	24
5	10	7	4	21
6	8	7	8	23
7	7	8	7	23
8	9	7	8	24
9	11	7	6	24
10	6	7	7	20
11	5	7	5	17
12	7	5	3	15
13	7	7	7	21
14	6	7	6	19
15	3	9	4	16
16	3	5	2	10
17	2	3	3	8
18	5	4	3	12
19	2	4	8	14
20	2	1	5	8
21	0	8	8	16
22	2	8	6	16
23	0	8	3	11
24	11	11	7	29
25	1	10	5	16
26	0	9	7	16
27	0	7	6	13
28	1	9	5	15
29	0	10	2	12
30	0	6	2	8
31	0	5	2	7
32	2	4	1	7
33	4	4	1	9
34	3	7	2	12
35	1	4	3	8
36	8	4	1	13
37	4	7	1	12
38	7	6	4	17
39	0	6	0	6
40	0	2	5	7
41	2	1	3	6
42	3	4	0	7
43	2	3	1	6
44	2	0	0	2
45	1	0	5	6
46	0	2	5	7
47	11	5	7	23
48	11	6	5	22
49	4	6	2	12
50	2	2	4	8
51	5	6	0	11
52	6	4	6	16
53	11	7	3	21

Table A1 continued.

Time	Compartment one	Compartment two	Compartment three	Total
54	11	7	5	23
55	5	5	4	14
56	11	2	4	17
57	6	4	4	14
58	0	2	2	4
59	6	3	4	13
60	4	6	1	11
61	3	2	0	5
62	4	4	0	8
63	4	3	0	7
64	4	9	0	13
65	3	9	2	14
66	0	5	1	6
67	3	0	1	4
68	11	3	0	14
69	3	5	0	8
70	4	0	0	4
71	2	9	1	12
72	2	4	0	6
73	2	4	2	8
74	2	6	0	8
75	0	3	0	3
76	0	3	0	3
77	2	1	0	3
78	8	4	3	15
79	2	7	2	11
80	0	2	1	3
81	0	3	0	3
82	4	4	1	9
83	0	6	0	6
84	1	1	1	3
85	5	2	0	7
86	3	8	0	11
87	0	2	0	2
88	0	7	2	9
89	8	5	1	14
90	5	7	1	13

Table A2. Number of horses ‘alert’ at each minute of stop two of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	0	2	2
2	4	1	1	6
3	2	6	2	10
4	0	3	1	4
5	1	3	0	4
6	1	3	1	5
7	1	0	0	1
8	1	3	0	4
9	1	4	1	6
10	0	2	1	3
11	0	6	0	6
12	0	0	0	0
13	1	3	0	4
14	1	3	1	5
15	0	1	0	1
16	0	1	2	3
17	0	1	2	3
18	0	3	0	3
19	1	2	3	6
20	4	2	1	7
21	0	2	0	2
22	3	3	3	9
23	5	3	0	8
24	2	1	0	3
25	2	2	0	4
26	2	1	8	11
27	11	5	2	18
28	6	3	1	10
29	7	5	2	14
30	2	5	1	8
31	3	5	0	8
32	0	1	0	1
33	0	4	0	4
34	0	6	4	10
35	3	7	0	10
36	0	5	3	8
37	0	6	2	8
38	4	6	0	10
39	0	2	3	5
40	0	6	2	8
41	0	5	1	6
42	2	2	2	6
43	2	0	0	2
44	3	2	1	6
45	0	4	0	4
46	2	5	6	13
47	1	2	7	10
48	1	6	4	11
49	0	2	3	5
50	0	2	5	7
51	4	6	3	13
52	4	3	1	8
53	0	0	7	7
54	3	2	2	7
55	0	2	2	4

Table A2 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	0	3	1	4
57	0	1	3	4
58	0	4	0	4
59	0	2	2	4
60	0	3	10	13
61	4	5	5	14
62	2	3	3	8
63	1	3	4	8
64	0	5	2	7
65	0	3	1	4
66	0	3	1	4
67	0	5	5	10
68	3	11	6	20
69	1	10	2	13
70	4	8	7	19
71	3	9	2	14
72	0	7	0	7
73	6	4	1	11
74	2	2	0	4
75	2	4	4	10
76	3	2	2	7
77	5	3	1	9
78	1	2	0	3
79	2	2	0	4
80	1	5	0	6
81	2	3	1	6
82	3	4	3	10
83	0	1	0	1
84	0	2	3	5
85	0	3	2	5
86	0	2	3	5
87	0	3	3	6
88	5	5	1	11
89	2	1	3	6
90	3	4	3	10

Table A3. Number of horses alert at each minute of stop three of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	7	4	11
2	4	5	1	10
3	4	5	4	13
4	3	7	1	11
5	5	5	1	11
6	11	6	4	21
7	1	6	4	11
8	5	8	2	15
9	11	5	3	19
10	1	4	4	9
11	2	5	1	8
12	2	7	5	14
13	4	6	3	13
14	2	4	2	8
15	2	8	2	12
16	4	3	1	8
17	3	5	0	7
18	1	3	2	6
19	3	5	1	9
20	3	4	0	7
21	6	0	2	8
22	1	4	4	9
23	3	3	2	8
24	5	5	2	12
25	1	6	4	11
26	3	3	6	13
27	7	4	4	15
28	2	5	2	9
29	11	4	1	16
30	6	3	1	10
31	6	4	1	11
32	0	1	2	3
33	2	3	3	8
34	0	0	2	2
35	4	2	0	6
36	6	3	2	11
37	0	1	2	3
38	4	1	2	7
39	2	0	1	3
40	2	2	1	5
41	11	1	0	12
42	6	1	1	8
43	3	4	3	10
44	11	6	7	24
45	11	5	5	21
46	11	4	4	19
47	11	1	3	15
48	2	1	1	4
49	2	3	1	6
50	2	4	1	7
51	3	0	1	4
52	0	2	2	4
53	0	2	1	3
54	4	4	6	14
55	1	4	1	6

Table A3 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	0	3	0	3
57	3	5	2	10
58	6	3	0	9
59	0	4	1	5
60	0	7	1	8
61	2	3	0	5
62	1	3	0	4
63	2	6	0	8
64	0	4	4	8
65	2	7	4	13
66	6	7	7	20
67	4	7	4	15
68	5	3	5	13
69	3	10	3	16
70	0	6	4	10
71	0	9	2	11
72	0	7	2	9
73	2	5	2	9
74	6	5	1	12
75	4	10	1	15
76	5	10	0	15
77	3	6	2	11
78	2	3	1	6
79	0	4	1	5
80	4	1	1	6
81	0	3	0	3
82	6	3	0	9
83	4	0	1	5
84	0	1	2	3
85	2	5	3	10
86	1	2	2	5
87	3	2	1	6
88	1	2	0	3
89	1	0	0	1
90	2	5	1	8

Table A4. Number of horses alert at each minute of stop one of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	2	5	9	16
2	5	4	8	17
3	5	4	10	19
4	5	6	10	21
5	7	5	10	22
6	6	8	6	20
7	4	3	8	15
8	6	3	7	16
9	5	6	9	20
10	9	4	8	21
11	6	2	8	16
12	6	3	9	18
13	6	2	7	15
14	9	1	6	16
15	6	2	7	15
16	8	2	6	16
17	10	2	9	21
18	9	3	8	20
19	4	5	7	16
20	5	4	5	14
21	5	1	4	10
22	4	3	7	14
23	6	2	6	14
24	6	3	9	18
25	7	2	8	17
26	8	3	5	16
27	7	3	5	15
28	6	2	3	11
29	10	9	9	28
30	7	2	9	18
31	7	1	5	13
32	5	3	4	12
33	5	5	6	16
34	6	1	5	12
35	6	1	7	14
36	7	0	4	11
37	4	3	6	13
38	6	1	6	13
39	7	3	5	15
40	8	3	6	17
41	6	3	6	15
42	6	2	5	13
43	4	0	7	11
44	7	3	7	17
45	7	3	9	19
46	7	2	8	17
47	4	1	7	12
48	5	0	6	11
49	7	3	6	16
50	6	2	8	16
51	3	0	6	9
52	6	0	4	10
53	4	1	4	9
54	5	1	4	10
55	4	3	5	12

Table A4 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	8	0	4	12
57	7	2	9	18
58	4	5	11	20
59	7	2	8	17
60	5	2	7	14
61	5	0	8	13
62	7	3	9	19
63	4	1	6	11
64	6	4	5	15
65	6	4	9	19
66	8	2	9	19
67	6	2	10	18
68	4	3	9	16
69	8	3	6	17
70	7	1	3	11
71	8	4	6	18
72	6	0	6	12
73	7	1	4	12
74	8	3	4	15
75	5	1	3	9
76	6	2	4	12
77	7	1	5	13
78	6	4	3	13
79	7	4	3	14
80	6	1	4	11
81	6	4	4	14
82	8	1	3	12
83	7	3	3	13
84	4	6	10	20
85	7	6	10	23
86	7	3	11	21
87	5	3	10	18
88	5	2	9	16
89	4	5	2	11
90	6	5	2	13

Table A5. Number of horses alert at each minute of stop two of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	10	5	3	18
2	9	4	7	20
3	10	6	8	24
4	8	2	7	17
5	7	7	9	23
6	5	2	10	17
7	5	4	8	17
8	8	4	8	20
9	8	2	4	14
10	8	8	8	24
11	8	5	8	21
12	3	5	8	16
13	3	3	6	12
14	5	1	4	10
15	6	1	4	11
16	7	1	3	11
17	5	3	2	10
18	6	6	4	16
19	5	2	7	14
20	9	2	5	16
21	6	2	3	11
22	7	0	2	9
23	5	5	2	12
24	6	7	4	17
25	5	2	3	10
26	7	2	2	11
27	6	3	2	11
28	6	4	1	11
29	8	1	6	15
30	5	2	4	11
31	5	1	2	8
32	9	4	5	18
33	6	2	4	12
34	5	1	2	8
35	8	9	2	19
36	6	10	2	18
37	8	10	7	25
38	6	6	3	15
39	5	0	2	7
40	3	3	1	7
41	6	3	1	10
42	4	5	7	16
43	6	4	6	16
44	6	4	4	14
45	6	8	10	24
46	6	7	6	19
47	6	5	4	15
48	7	4	4	15
49	5	3	3	11
50	4	4	3	11
51	7	7	9	23
52	5	3	11	19
53	8	6	11	25
54	7	5	11	23
55	5	5	11	21

Table A5 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	7	4	11	22
57	5	0	10	15
58	8	3	10	21
59	4	4	11	19
60	4	2	10	16
61	8	4	10	22
62	5	6	11	22
63	8	2	9	19
64	2	1	8	11
65	6	5	6	17
66	8	5	4	17
67	6	3	3	12
68	8	4	3	15
69	7	6	8	21
70	7	1	10	18
71	6	0	10	16
72	6	3	11	20
73	7	10	11	28
74	7	6	11	24
75	9	5	11	25
76	5	4	11	20
77	10	10	11	31
78	8	7	11	26
79	6	5	9	20
80	7	2	9	18
81	8	5	10	23
82	8	2	10	20
83	9	8	7	24
84	5	3	11	19
85	9	10	11	30
86	6	4	10	20
87	12	10	11	33
88	10	8	11	29
89	9	5	11	25
90	6	5	11	22

Table A6. Number of horses alert at each minute of stop three of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	7	6	11	24
2	8	7	9	24
3	7	6	6	19
4	7	5	4	16
5	7	6	9	22
6	3	6	5	14
7	5	5	4	14
8	8	5	3	16
9	6	6	4	16
10	6	3	2	11
11	5	4	1	10
12	7	7	10	24
13	7	7	6	20
14	7	4	5	16
15	7	6	4	17
16	7	5	5	17
17	6	4	8	18
18	6	4	7	17
19	8	7	3	18
20	5	3	4	12
21	5	5	3	13
22	5	4	3	12
23	5	7	5	17
24	12	10	8	30
25	9	6	9	24
26	10	6	8	24
27	10	2	3	15
28	8	0	3	11
29	8	3	4	15
30	8	5	3	16
31	9	6	4	19
32	11	4	6	21
33	7	9	10	26
34	5	8	9	22
35	7	6	7	20
36	10	7	10	27
37	8	6	5	19
38	5	6	7	18
39	6	6	9	21
40	7	4	9	20
41	5	4	10	19
42	7	2	9	18
43	9	3	9	21
44	9	6	8	23
45	8	7	5	20
46	4	2	4	10
47	9	4	7	20
48	3	2	3	8
49	5	1	2	8
50	7	0	1	8
51	7	0	3	10
52	9	4	9	22
53	12	5	10	27
54	9	4	8	21
55	9	2	7	18

Table A6 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	5	0	4	9
57	9	0	3	12
58	6	2	6	14
59	4	3	6	13
60	7	2	2	11
61	6	1	3	10
62	8	4	5	17
63	7	5	3	15
64	10	1	3	14
65	4	0	1	5
66	8	1	2	11
67	7	2	2	11
68	10	3	3	16
69	9	2	2	13
70	10	4	7	21
71	8	0	2	10
72	10	5	5	20
73	7	3	3	13
74	9	0	5	14
75	8	1	4	13
76	9	4	2	15
77	6	0	1	7
78	8	4	2	14
79	9	0	2	11
80	8	4	3	15
81	8	3	2	13
82	10	0	5	15
83	8	0	3	11
84	8	2	5	15
85	5	0	2	7
86	10	1	4	15
87	10	1	4	15
88	9	2	2	13
89	8	0	4	12
90	8	3	3	14

Table A7. Number of horses resting at each minute of stop one of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	0	0	0
2	0	0	0	0
3	0	3	3	6
4	0	3	3	6
5	0	3	6	9
6	0	3	2	5
7	3	3	2	8
8	0	4	2	6
9	0	4	4	8
10	5	3	3	11
11	6	4	5	15
12	4	5	7	16
13	4	3	2	9
14	5	4	4	13
15	8	2	6	16
16	8	6	8	22
17	9	8	7	24
18	6	7	6	19
19	9	7	2	18
20	9	10	5	24
21	11	3	2	16
22	9	3	4	16
23	11	3	7	21
24	0	0	3	3
25	10	1	5	16
26	11	2	3	16
27	11	4	4	19
28	10	2	5	17
29	11	1	8	20
30	11	4	8	23
31	11	4	8	23
32	9	7	9	25
33	7	7	9	23
34	8	4	8	20
35	10	7	7	24
36	3	6	9	18
37	7	4	9	20
38	4	5	6	15
39	11	6	10	27
40	11	9	5	25
41	9	10	7	26
42	8	7	10	25
43	9	8	9	26
44	9	11	10	30
45	10	11	5	26
46	11	9	5	25
47	0	6	3	9
48	0	5	5	10
49	7	5	8	20
50	9	9	6	24
51	6	5	10	21
52	5	7	4	16
53	0	4	7	11
54	0	4	5	9
55	6	6	6	18

Table A7 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	0	9	6	15
57	5	7	5	17
58	11	9	8	28
59	5	8	6	19
60	7	5	9	21
61	8	9	10	27
62	7	7	10	24
63	7	8	10	25
64	7	2	10	19
65	8	2	8	18
66	11	6	9	26
67	8	11	9	28
68	0	8	10	18
69	8	6	10	24
70	7	11	10	28
71	9	2	9	20
72	9	7	10	26
73	9	7	8	24
74	9	5	10	24
75	11	8	10	29
76	11	8	10	29
77	9	10	10	29
78	3	7	7	17
79	9	4	8	21
80	11	9	9	29
81	11	8	10	29
82	7	7	9	23
83	11	5	10	26
84	10	10	9	29
85	6	9	10	25
86	8	3	10	21
87	11	9	10	30
88	11	4	8	23
89	3	6	9	18
90	6	4	9	19

Table A8. Number of horses resting at each minute of stop two of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	11	11	8	30
2	7	10	9	26
3	9	5	8	22
4	11	8	9	28
5	10	8	10	28
6	10	8	9	27
7	10	11	10	31
8	10	8	10	28
9	10	7	9	26
10	11	9	9	29
11	11	5	10	26
12	11	11	10	32
13	10	8	10	28
14	10	8	9	27
15	11	10	10	31
16	11	10	8	29
17	11	10	8	29
18	11	11	9	31
19	10	9	7	26
20	7	9	9	25
21	11	9	10	30
22	8	8	7	23
23	6	8	10	24
24	9	10	10	29
25	9	9	10	28
26	9	10	2	21
27	0	6	8	14
28	5	8	9	22
29	4	6	8	18
30	9	6	9	24
31	8	6	10	24
32	11	10	10	31
33	11	7	10	28
34	11	5	6	22
35	8	4	10	22
36	11	6	7	24
37	11	5	8	24
38	7	5	10	22
39	11	9	7	27
40	11	5	8	24
41	11	6	9	26
42	9	9	8	26
43	9	11	10	30
44	8	9	9	26
45	11	7	10	28
46	9	6	4	19
47	10	9	3	22
48	10	5	6	21
49	11	9	7	27
50	11	9	5	25
51	7	5	7	19
52	7	8	9	24
53	11	11	3	25
54	8	9	8	25
55	11	9	8	28

Table A8 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	11	8	9	28
57	11	10	7	28
58	11	7	10	28
59	11	9	8	28
60	11	8	0	19
61	7	6	5	18
62	9	8	6	23
63	10	8	6	24
64	11	6	8	25
65	11	8	9	28
66	11	8	9	28
67	11	6	5	22
68	8	0	4	12
69	10	1	8	19
70	7	3	3	13
71	8	2	8	18
72	11	4	10	25
73	5	7	9	21
74	9	9	10	28
75	9	7	6	22
76	8	9	8	25
77	6	8	9	23
78	10	9	10	29
79	9	9	10	28
80	10	6	10	26
81	9	8	9	26
82	8	7	7	22
83	11	10	10	31
84	11	9	7	27
85	11	8	8	27
86	11	9	7	27
87	11	8	7	26
88	6	6	9	21
89	9	10	7	26
90	8	7	7	22

Table A9. Number of horses resting at each minute of stop three of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	11	4	6	21
2	7	6	8	21
3	7	6	6	19
4	8	4	9	21
5	6	6	9	21
6	0	5	6	11
7	10	5	6	21
8	6	3	8	17
9	0	6	7	13
10	10	7	6	23
11	9	6	9	24
12	9	4	5	18
13	7	4	7	18
14	9	7	8	24
15	9	3	8	20
16	7	8	9	24
17	8	6	10	24
18	10	8	8	26
19	8	6	9	23
20	8	7	10	25
21	5	11	8	24
22	10	7	6	23
23	8	8	8	24
24	6	6	8	20
25	10	5	6	21
26	8	8	4	20
27	4	7	6	17
28	9	6	8	23
29	0	7	9	16
30	5	8	9	22
31	5	7	9	21
32	11	10	8	29
33	9	8	7	24
34	11	11	8	30
35	7	9	10	26
36	5	8	8	21
37	11	10	8	29
38	7	10	8	25
39	9	11	9	29
40	9	9	9	27
41	0	10	10	20
42	5	10	9	24
43	8	7	7	22
44	0	5	3	8
45	0	6	5	11
46	0	7	6	13
47	0	10	7	17
48	9	10	9	28
49	9	8	9	26
50	9	7	9	25
51	8	11	9	28
52	11	9	8	28
53	11	9	9	29
54	7	7	4	28
55	10	7	9	26

Table A9 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	11	8	10	29
57	8	6	8	22
58	5	8	10	23
59	11	7	9	27
60	11	4	9	24
61	9	8	10	27
62	10	8	10	28
63	9	5	10	24
64	11	7	6	24
65	9	4	5	18
66	5	4	3	12
67	7	4	6	17
68	6	8	5	19
69	8	0	7	15
70	11	5	6	22
71	11	2	8	21
72	11	4	8	23
73	9	6	8	23
74	5	6	9	20
75	7	1	9	17
76	6	1	10	17
77	8	5	8	21
78	9	8	9	26
79	11	7	9	27
80	7	10	9	26
81	11	8	10	29
82	5	8	10	23
83	7	11	9	27
84	11	10	8	29
85	9	6	7	22
86	10	9	8	27
87	8	9	9	26
88	10	9	10	29
89	10	11	10	31
90	9	9	9	27

Table A10. Number of horses resting at each minute of stop one of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	11	3	2	16
2	9	3	3	15
3	6	3	1	10
4	6	3	1	10
5	4	5	1	10
6	5	2	5	12
7	7	7	3	17
8	6	7	4	17
9	7	4	2	13
10	3	6	3	12
11	5	7	3	15
12	6	6	2	14
13	4	7	4	15
14	3	9	5	17
15	5	7	4	16
16	2	7	5	14
17	0	8	2	10
18	2	7	3	12
19	6	5	4	15
20	6	6	6	18
21	6	9	7	22
22	6	7	4	17
23	5	8	5	18
24	5	7	2	14
25	4	8	3	15
26	3	7	6	16
27	4	7	6	17
28	5	8	8	21
29	1	0	2	3
30	4	8	2	14
31	3	9	6	18
32	5	7	7	19
33	6	5	5	16
34	5	9	6	20
35	6	8	4	18
36	4	9	7	20
37	6	7	5	18
38	4	8	5	17
39	3	7	6	16
40	3	7	5	15
41	4	7	5	16
42	4	8	6	18
43	6	10	4	20
44	4	7	4	15
45	5	7	2	14
46	4	8	3	15
47	6	9	4	19
48	5	10	5	20
49	5	6	5	16
50	5	8	3	16
51	7	10	5	22
52	6	10	7	23
53	8	9	7	24
54	7	9	7	23
55	8	7	6	21

Table A10 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	4	10	7	21
57	5	8	2	15
58	8	5	0	13
59	5	8	3	16
60	7	8	4	19
61	7	10	3	20
62	5	7	2	11
63	8	9	5	22
64	6	6	6	18
65	6	6	2	14
66	4	8	2	14
67	6	8	1	15
68	7	7	2	16
69	4	7	5	16
70	5	9	7	21
71	4	5	5	14
72	6	10	5	21
73	5	9	7	21
74	4	7	7	18
75	5	9	8	22
76	6	8	7	21
77	5	9	6	20
78	5	6	8	19
79	4	6	8	18
80	6	9	7	22
81	6	6	7	19
82	3	9	8	20
83	4	7	8	19
84	6	4	1	11
85	3	4	1	8
86	3	7	0	10
87	5	7	1	13
88	5	8	2	15
89	6	5	9	20
90	4	5	9	18

Table A11. Number of horses resting at each minute of stop two of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	4	8	12
2	1	6	4	11
3	0	4	3	7
4	2	8	3	13
5	3	3	2	8
6	5	8	1	14
7	5	5	3	13
8	2	5	3	10
9	3	7	7	17
10	4	2	3	9
11	2	5	3	10
12	7	5	3	15
13	7	6	5	18
14	6	8	7	21
15	4	7	7	18
16	3	7	8	18
17	5	5	9	19
18	4	3	7	14
19	5	7	4	16
20	2	7	6	15
21	5	7	8	20
22	3	9	9	21
23	6	5	9	20
24	4	3	7	14
25	5	8	8	21
26	4	7	9	20
27	4	7	9	20
28	4	6	10	20
29	2	9	5	16
30	5	8	7	20
31	5	8	9	22
32	2	6	6	14
33	4	8	7	19
34	5	8	9	22
35	3	1	9	13
36	5	0	9	14
37	4	0	4	8
38	6	4	8	18
39	4	9	9	22
40	8	7	10	25
41	5	7	10	22
42	7	5	4	16
43	6	5	5	16
44	5	6	7	18
45	5	2	1	8
46	5	3	5	13
47	2	5	7	14
48	4	4	7	15
49	5	6	8	19
50	6	5	8	19
51	3	3	2	8
52	5	7	0	12
53	2	4	0	6
54	3	5	0	8
55	6	5	0	11

Table A11 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	4	6	0	10
57	5	10	1	16
58	2	7	1	10
59	7	6	0	13
60	6	8	1	15
61	3	6	1	10
62	5	4	0	9
63	2	8	2	12
64	8	9	3	20
65	4	5	5	14
66	4	5	7	16
67	5	7	8	20
68	3	6	8	17
69	3	4	3	10
70	3	9	1	13
71	4	9	1	14
72	4	7	0	11
73	3	0	0	3
74	3	4	0	7
75	1	5	0	6
76	5	6	0	11
77	0	0	0	0
78	2	2	0	4
79	4	5	2	11
80	3	7	2	12
81	2	5	1	8
82	2	8	1	11
83	2	2	4	10
84	5	7	0	12
85	2	0	0	2
86	4	4	1	9
87	0	0	0	0
88	0	2	0	2
89	0	5	0	5
90	3	5	0	8

Table A12. Number of horses resting at each minute of stop three of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	3	4	0	7
2	3	3	2	8
3	3	4	5	12
4	4	5	7	16
5	4	4	2	10
6	8	4	6	18
7	6	5	7	18
8	4	5	8	17
9	6	4	7	17
10	6	7	9	22
11	7	5	10	22
12	5	3	1	9
13	5	3	5	13
14	5	6	6	17
15	5	4	7	16
16	5	5	6	16
17	6	6	3	15
18	6	6	4	16
19	4	3	8	15
20	7	7	7	21
21	7	5	8	20
22	7	6	8	21
23	7	3	6	16
24	0	0	3	3
25	3	2	2	7
26	2	3	3	8
27	2	7	8	17
28	4	10	8	22
29	4	7	7	18
30	4	4	8	16
31	3	4	7	14
32	1	6	5	12
33	5	0	1	6
34	7	2	2	11
35	5	4	4	13
36	2	3	1	6
37	4	4	6	14
38	7	4	4	15
39	6	4	2	12
40	5	5	2	12
41	7	5	1	13
42	5	8	2	15
43	3	7	2	12
44	3	4	3	10
45	4	3	6	13
46	8	8	7	23
47	3	6	4	13
48	9	8	8	25
49	7	9	9	25
50	5	10	10	25
51	5	10	8	23
52	3	6	2	11
53	0	5	1	6
54	3	6	3	12
55	3	8	4	15

Table A12 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	7	10	7	24
57	3	10	8	21
58	6	8	5	19
59	8	7	5	20
60	5	8	9	22
61	6	9	8	23
62	4	6	6	16
63	5	5	8	18
64	2	9	8	19
65	8	10	10	28
66	4	9	9	22
67	5	8	9	22
68	2	7	8	17
69	3	8	9	20
70	2	6	4	12
71	4	10	9	23
72	2	5	6	13
73	5	7	8	20
74	3	10	6	19
75	4	9	7	20
76	3	6	9	18
77	6	10	10	26
78	4	6	9	19
79	3	10	9	22
80	4	6	8	18
81	4	7	9	20
82	2	10	6	18
83	4	10	8	22
84	4	8	6	18
85	7	10	9	26
86	2	9	7	18
87	2	9	7	18
88	3	8	9	20
89	4	10	7	21
90	4	7	8	19

Table A13. Number of horses moving at each minute of stop one of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	11	8	19
2	0	7	3	10
3	6	0	3	9
4	5	2	1	8
5	4	0	1	5
6	3	1	4	8
7	4	2	4	10
8	3	2	7	12
9	0	3	3	6
10	0	2	4	6
11	0	1	2	3
12	4	0	2	6
13	2	2	6	10
14	0	1	4	5
15	2	2	2	6
16	3	1	1	5
17	2	2	2	6
18	0	2	2	4
19	2	2	7	11
20	2	0	2	4
21	0	1	7	8
22	2	0	4	6
23	0	0	2	2
24	0	11	5	16
25	1	2	2	5
26	0	0	2	2
27	0	6	3	9
28	1	0	3	4
29	0	3	0	3
30	0	0	1	1
31	0	1	1	2
32	2	2	1	5
33	2	0	0	2
34	2	0	1	3
35	1	0	2	3
36	4	1	0	5
37	2	1	0	3
38	0	3	2	5
39	0	2	0	2
40	0	0	3	3
41	2	0	2	4
42	3	1	0	4
43	2	1	0	3
44	2	0	0	2
45	1	0	3	4
46	0	0	4	4
47	5	2	6	13
48	2	0	4	6
49	2	0	0	2
50	2	0	3	5
51	5	0	0	5
52	6	1	4	11
53	11	0	2	13
54	8	4	3	15
55	5	3	1	9

Table A13 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	7	1	1	9
57	6	1	2	9
58	0	2	0	2
59	6	0	2	8
60	4	3	0	7
61	3	0	0	3
62	4	1	0	5
63	4	3	0	7
64	4	4	0	8
65	3	0	1	4
66	0	0	0	0
67	3	0	0	3
68	4	1	0	5
69	3	3	0	6
70	4	0	0	4
71	2	2	0	4
72	2	0	0	2
73	2	0	1	3
74	2	3	0	5
75	0	2	0	2
76	0	0	0	0
77	2	0	0	2
78	4	1	2	7
79	2	3	0	5
80	0	0	0	0
81	0	1	0	1
82	4	1	0	5
83	0	3	0	3
84	1	0	0	1
85	5	0	0	5
86	3	0	0	3
87	0	0	0	0
88	0	3	0	3
89	8	2	0	10
90	5	3	0	8

Table A14. Number of horses moving at each minute of stop two of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	0	0	0
2	4	0	0	4
3	2	2	1	5
4	0	0	0	0
5	1	3	0	4
6	1	0	0	1
7	1	0	0	1
8	1	2	0	3
9	1	2	0	3
10	0	2	0	2
11	0	4	0	4
12	0	0	0	0
13	1	2	0	3
14	1	3	0	4
15	0	1	0	1
16	0	1	0	1
17	0	1	1	2
18	0	0	0	0
19	1	2	1	4
20	4	2	0	6
21	0	0	0	0
22	3	0	1	4
23	5	1	0	6
24	2	0	0	2
25	2	1	0	3
26	2	0	5	7
27	4	0	0	4
28	6	1	0	7
29	4	2	0	6
30	2	1	0	3
31	3	1	0	4
32	0	0	0	0
33	0	1	0	1
34	0	4	2	6
35	3	5	0	8
36	0	2	1	3
37	0	2	1	3
38	4	4	0	8
39	0	1	2	3
40	0	3	0	3
41	0	2	0	2
42	2	1	2	5
43	2	0	0	2
44	3	2	1	6
45	0	1	0	1
46	2	1	2	5
47	1	2	5	8
48	1	2	3	6
49	0	0	1	1
50	0	1	3	4
51	4	5	1	10
52	4	0	0	4
53	0	0	4	4
54	3	1	0	4
55	0	1	1	2

Table A14 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	0	1	0	1
57	0	0	1	1
58	0	2	0	2
59	0	1	0	1
60	0	0	7	7
61	4	3	3	10
62	2	0	2	4
63	1	1	2	4
64	0	3	0	3
65	0	0	0	0
66	0	2	0	2
67	0	3	3	6
68	3	2	2	7
69	1	3	1	5
70	4	0	3	7
71	3	3	0	6
72	0	1	0	1
73	6	0	1	7
74	2	2	0	4
75	2	2	2	6
76	3	1	0	4
77	2	0	0	2
78	1	1	0	2
79	2	0	0	2
80	1	2	0	3
81	2	0	0	2
82	3	0	0	3
83	0	0	0	0
84	0	0	1	1
85	0	1	0	1
86	0	0	0	0
87	0	0	1	1
88	5	2	0	7
89	2	0	1	3
90	3	3	0	6

Table A15. Number of horses moving at each minute of stop three of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	0	0	0
2	4	0	0	4
3	4	2	1	7
4	3	2	1	6
5	5	1	1	7
6	11	0	2	13
7	1	0	1	2
8	5	2	1	8
9	5	0	2	7
10	1	2	2	5
11	2	2	0	4
12	2	3	3	8
13	4	0	1	5
14	2	2	0	4
15	2	4	2	8
16	4	3	0	7
17	3	0	0	3
18	1	3	0	4
19	3	0	1	4
20	3	2	0	5
21	6	0	1	7
22	1	4	3	8
23	3	0	0	3
24	5	0	1	6
25	1	3	3	7
26	3	1	4	8
27	7	1	2	10
28	2	1	0	3
29	6	2	0	8
30	6	1	1	8
31	6	0	0	6
32	0	1	1	2
33	2	0	2	4
34	0	0	1	1
35	4	0	0	4
36	6	0	1	7
37	0	0	0	0
38	4	0	1	5
39	2	0	0	2
40	2	2	0	4
41	8	1	0	9
42	6	0	0	6
43	3	3	2	8
44	0	2	5	7
45	5	2	3	10
46	0	0	2	2
47	4	1	1	6
48	2	0	0	2
49	2	3	0	5
50	2	2	1	5
51	3	0	0	3
52	0	2	1	3
53	0	1	0	1
54	4	3	4	11
55	1	0	0	1

Table A15 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	0	0	0	0
57	3	0	0	3
58	6	0	0	6
59	0	0	1	1
60	0	3	0	3
61	1	0	0	1
62	1	1	0	2
63	2	4	0	6
64	0	2	0	2
65	2	3	2	7
66	0	6	4	10
67	4	4	0	8
68	5	2	3	10
69	3	4	0	7
70	0	0	2	2
71	0	3	0	3
72	0	2	0	2
73	2	0	1	3
74	6	0	1	7
75	4	5	0	9
76	5	7	0	12
77	3	3	1	7
78	2	1	0	3
79	0	3	0	3
80	4	0	1	5
81	0	3	0	3
82	6	2	0	8
83	4	0	0	4
84	0	0	1	1
85	2	0	1	3
86	1	2	1	4
87	3	0	0	3
88	1	1	0	2
89	1	0	0	1
90	2	2	0	4

Table A16. Number of horses moving at each minute of stop one of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	2	2	3	7
2	3	1	4	11
3	4	2	7	13
4	3	5	8	16
5	3	3	8	14
6	5	0	4	9
7	4	1	5	10
8	5	1	5	11
9	5	3	6	14
10	6	3	3	12
11	4	0	5	9
12	3	1	3	7
13	4	0	2	6
14	7	1	1	9
15	5	1	4	10
16	8	0	4	12
17	8	2	7	17
18	6	3	4	13
19	3	5	1	9
20	0	2	1	3
21	1	0	1	2
22	2	2	3	7
23	4	1	2	7
24	4	2	5	11
25	2	1	3	6
26	5	1	2	8
27	1	1	2	4
28	3	1	1	5
29	6	1	7	14
30	6	1	4	11
31	2	0	2	4
32	3	2	4	9
33	4	3	4	11
34	4	0	3	7
35	3	0	5	8
36	2	0	3	5
37	2	1	5	8
38	2	0	4	6
39	5	3	4	12
40	8	2	5	15
41	4	2	4	10
42	4	0	3	7
43	4	0	6	10
44	5	2	6	13
45	4	2	7	13
46	3	1	6	10
47	3	1	3	7
48	5	0	3	8
49	5	3	1	9
50	6	1	5	12
51	1	0	2	3
52	2	0	3	5
53	2	1	2	5
54	2	1	2	5
55	0	2	4	6

Table A16 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	3	0	2	5
57	5	2	4	11
58	2	3	10	15
59	5	0	2	7
60	2	0	2	4
61	3	0	3	6
62	2	1	4	7
63	4	1	5	10
64	1	3	3	7
65	3	2	8	13
66	4	2	6	12
67	3	2	7	12
68	3	3	2	8
69	6	1	1	8
70	3	0	1	4
71	5	1	2	8
72	3	0	5	8
73	4	0	2	6
74	5	3	2	10
75	4	0	1	5
76	3	1	3	7
77	2	1	3	6
78	4	4	1	9
79	2	4	2	8
80	5	1	3	9
81	4	4	1	9
82	6	1	1	8
83	4	2	1	7
84	2	4	10	16
85	5	1	9	15
86	2	3	8	13
87	4	2	6	12
88	4	2	2	8
89	3	5	0	8
90	4	3	0	7

Table A17. Number of horses moving at each minute of stop two of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	4	3	0	7
2	3	0	5	8
3	4	2	7	13
4	5	1	5	11
5	4	3	7	14
6	3	2	8	13
7	5	0	5	10
8	3	2	3	8
9	5	1	2	8
10	4	5	6	15
11	6	1	3	10
12	2	2	2	6
13	2	2	1	5
14	1	1	1	3
15	4	1	0	5
16	5	1	1	7
17	2	3	0	5
18	3	4	2	9
19	4	1	4	9
20	6	2	3	11
21	3	2	1	6
22	4	0	0	4
23	3	3	0	6
24	6	4	2	12
25	4	1	1	6
26	4	1	0	5
27	4	1	0	5
28	5	3	0	8
29	4	0	3	7
30	3	0	2	5
31	3	0	0	3
32	6	2	3	11
33	1	0	2	3
34	2	1	0	3
35	8	2	0	10
36	6	4	1	11
37	2	5	4	11
38	4	2	1	7
39	2	0	0	2
40	2	2	0	4
41	4	1	1	6
42	2	2	5	9
43	3	0	4	7
44	3	3	1	7
45	2	3	8	13
46	4	4	5	13
47	2	2	3	7
48	3	1	2	6
49	2	2	3	7
50	4	0	1	5
51	4	3	7	14
52	4	2	10	16
53	3	0	10	13
54	4	1	11	16
55	2	0	9	11

Table A17 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	4	0	7	11
57	3	0	8	11
58	2	1	7	10
59	2	2	10	14
60	3	1	7	11
61	2	2	8	12
62	4	0	8	12
63	6	1	7	14
64	2	0	5	7
65	4	3	4	11
66	1	4	2	7
67	4	1	2	7
68	4	2	2	8
69	5	2	6	13
70	3	0	8	11
71	3	0	6	9
72	5	0	11	16
73	2	4	11	17
74	3	1	11	15
75	4	1	11	16
76	3	2	10	15
77	7	5	11	23
78	4	2	8	14
79	4	3	5	12
80	5	0	6	11
81	4	1	7	12
82	5	0	7	12
83	6	3	5	14
84	2	2	8	12
85	6	3	10	19
86	3	1	8	12
87	12	10	10	32
88	10	4	9	23
89	4	0	8	12
90	5	0	7	12

Table A18. Number of horses moving at each minute of stop three of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	3	4	3	10
2	4	3	3	10
3	3	2	2	7
4	4	0	2	6
5	5	4	4	13
6	3	2	3	8
7	1	2	2	5
8	3	2	2	7
9	3	4	2	9
10	3	1	1	5
11	3	3	1	7
12	3	5	7	15
13	6	3	4	13
14	2	3	3	8
15	4	3	2	9
16	5	2	3	10
17	2	2	6	10
18	3	2	4	9
19	5	5	2	12
20	2	2	2	6
21	3	4	1	8
22	5	2	0	7
23	2	4	4	10
24	5	0	5	10
25	6	1	2	9
26	8	2	3	13
27	5	1	1	7
28	6	0	2	8
29	2	1	1	4
30	4	2	0	6
31	1	3	0	4
32	4	2	3	9
33	4	7	8	19
34	1	3	3	7
35	3	2	2	7
36	4	0	5	9
37	3	3	2	8
38	3	5	2	10
39	4	4	6	14
40	5	0	2	7
41	3	0	4	7
42	4	0	3	7
43	4	3	5	12
44	7	0	2	9
45	3	4	2	9
46	2	0	2	4
47	6	0	3	9
48	0	1	1	2
49	2	0	0	2
50	3	0	0	3
51	4	0	2	6
52	3	0	8	11
53	6	0	5	11
54	2	1	2	5
55	4	0	1	5

Table A18 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	4	0	1	5
57	5	0	1	6
58	3	2	1	6
59	1	3	2	6
60	3	2	0	5
61	2	1	1	4
62	5	4	2	11
63	4	2	1	7
64	3	0	0	3
65	3	0	0	3
66	3	1	1	5
67	3	0	0	3
68	4	1	2	7
69	4	2	0	6
70	7	0	3	10
71	4	0	0	4
72	4	2	3	9
73	4	0	0	4
74	5	0	3	8
75	4	1	1	6
76	5	0	0	5
77	2	0	0	2
78	4	2	1	7
79	3	0	0	3
80	5	3	2	10
81	5	3	1	9
82	6	0	3	9
83	5	0	2	7
84	4	2	3	9
85	3	0	0	3
86	6	0	3	9
87	4	1	0	5
88	4	1	0	5
89	4	0	2	6
90	3	1	2	6

Table A19. Number of horses standing alert at each minute of stop one of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	9	0	2	11
2	10	3	7	20
3	0	7	4	11
4	5	6	5	16
5	6	7	3	16
6	5	6	4	15
7	3	6	3	12
8	6	5	1	12
9	11	4	3	18
10	6	5	3	14
11	5	6	3	14
12	3	5	1	9
13	5	5	1	11
14	6	6	2	14
15	1	7	2	10
16	0	4	1	5
17	0	1	1	2
18	5	2	1	8
19	0	2	1	3
20	0	1	3	4
21	0	7	1	8
22	0	8	2	10
23	0	8	1	9
24	11	0	2	13
25	0	8	3	11
26	0	9	5	14
27	0	1	3	4
28	0	9	2	11
29	0	7	2	9
30	0	6	1	7
31	0	4	1	5
32	0	2	0	2
33	2	4	1	7
34	1	7	1	9
35	0	4	1	5
36	4	3	1	8
37	2	6	1	9
38	7	3	2	12
39	0	4	0	4
40	0	2	2	4
41	0	1	1	2
42	0	3	0	3
43	0	2	1	3
44	0	0	0	0
45	0	0	2	2
46	0	2	1	3
47	6	3	1	10
48	9	6	1	16
49	2	6	2	10
50	0	2	1	3
51	0	6	0	6
52	0	3	2	5
53	0	7	1	8
54	3	3	2	8
55	0	2	3	5

Table A19 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	4	1	3	8
57	0	3	2	5
58	0	0	2	2
59	0	3	2	5
60	0	3	1	4
61	0	2	0	2
62	0	3	0	3
63	0	0	0	0
64	0	5	0	5
65	0	9	1	10
66	0	5	1	6
67	0	0	1	1
68	7	2	0	9
69	0	2	0	2
70	0	0	0	0
71	0	7	1	8
72	0	4	0	4
73	0	4	1	5
74	0	3	0	3
75	0	1	0	1
76	0	3	0	3
77	0	1	0	1
78	4	3	1	8
79	0	4	2	6
80	0	2	1	3
81	0	2	0	2
82	0	3	1	4
83	0	3	0	3
84	0	1	1	2
85	0	2	0	2
86	0	8	0	8
87	0	2	0	2
88	0	4	2	6
89	0	3	1	4
90	0	4	1	5

Table A20. Number of horses standing alert at each minute of stop two of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	0	2	2
2	0	1	1	2
3	0	4	1	5
4	0	3	1	4
5	0	0	0	0
6	0	3	1	4
7	0	0	0	0
8	0	1	0	1
9	0	2	1	3
10	0	0	1	1
11	0	2	0	2
12	0	0	0	0
13	0	1	0	1
14	0	0	1	1
15	0	0	0	0
16	0	0	2	2
17	0	0	1	1
18	0	0	1	1
19	0	0	2	2
20	0	0	1	1
21	0	2	0	2
22	0	3	2	5
23	0	2	0	2
24	0	1	0	1
25	0	1	0	1
26	0	1	3	4
27	7	5	2	14
28	0	2	1	3
29	3	3	2	8
30	0	4	1	5
31	0	4	0	4
32	0	1	0	1
33	0	3	0	3
34	0	2	2	4
35	0	2	0	2
36	0	3	2	5
37	0	4	1	5
38	0	2	0	2
39	0	1	1	2
40	0	3	2	5
41	0	3	1	4
42	0	1	0	1
43	0	0	0	0
44	0	0	0	0
45	0	3	0	3
46	0	4	4	8
47	0	0	2	2
48	0	4	1	5
49	0	2	2	4
50	0	1	2	3
51	0	1	2	3
52	0	3	1	4
53	0	0	3	3
54	0	1	2	3
55	0	1	1	2

Table A20 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	0	2	1	3
57	0	1	2	3
58	0	2	0	2
59	0	1	2	3
60	0	3	3	6
61	0	2	2	4
62	0	3	1	4
63	0	2	2	4
64	0	2	2	4
65	0	3	1	4
66	0	1	1	2
67	0	2	2	4
68	0	9	4	13
69	0	7	1	8
70	0	8	4	12
71	0	6	2	8
72	0	6	0	6
73	0	4	0	4
74	0	0	0	0
75	0	2	2	4
76	0	1	2	3
77	3	3	1	7
78	0	1	0	1
79	0	2	0	2
80	0	3	0	3
81	0	3	1	4
82	0	4	3	7
83	0	1	0	1
84	0	2	2	4
85	0	2	2	4
86	0	2	3	5
87	0	3	2	5
88	0	3	1	4
89	0	1	2	3
90	0	1	3	4

Table A21. Number of horses standing alert at each minute of stop three of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	7	4	11
2	0	5	1	6
3	0	3	3	6
4	0	5	0	5
5	0	4	0	4
6	0	6	2	8
7	0	6	3	9
8	0	6	1	7
9	6	5	1	12
10	0	2	2	4
11	0	3	1	4
12	0	4	2	6
13	0	6	2	8
14	0	2	2	4
15	0	4	0	4
16	0	0	1	1
17	0	5	0	5
18	0	0	2	2
19	0	5	0	5
20	0	2	0	2
21	0	0	1	1
22	0	0	1	1
23	0	3	2	5
24	0	5	1	6
25	0	3	1	4
26	0	2	2	4
27	0	3	2	5
28	0	4	2	6
29	5	2	1	8
30	0	2	0	2
31	0	4	1	5
32	0	0	1	1
33	0	3	1	4
34	0	0	1	1
35	0	2	0	2
36	0	3	1	4
37	0	1	2	3
38	0	1	1	2
39	0	0	1	1
40	0	0	1	1
41	3	0	0	3
42	0	1	1	2
43	0	1	1	2
44	11	4	2	17
45	6	3	2	11
46	11	4	2	17
47	7	0	2	9
48	0	1	1	2
49	0	0	1	1
50	0	2	0	2
51	0	0	1	1
52	0	0	1	1
53	0	1	1	2

Table A21 continued.

Time	Compartment one	Compartment two	Compartment three	Total
54	0	1	2	3
55	0	4	1	5
56	0	3	0	3
57	0	5	2	7
58	0	3	0	3
59	0	4	0	4
60	0	4	1	5
61	1	3	0	4
62	0	2	0	2
63	0	2	0	2
64	0	2	4	6
65	0	4	2	6
66	6	1	3	10
67	0	3	4	7
68	0	1	2	3
69	0	6	3	9
70	0	6	2	8
71	0	6	2	8
72	0	5	2	7
73	0	5	1	6
74	0	5	0	5
75	0	5	1	6
76	0	3	0	3
77	0	3	1	4
78	0	2	1	3
79	0	1	1	2
80	0	1	0	1
81	0	0	0	0
82	0	1	0	1
83	0	0	1	1
84	0	1	1	2
85	0	5	2	7
86	0	0	1	1
87	0	2	1	3
88	0	1	0	1
89	0	0	0	0
90	0	0	1	1

Table A22. Number of horses standing alert at each minute of stop one of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	3	6	9
2	2	3	4	9
3	1	2	3	6
4	2	1	2	5
5	4	2	2	8
6	1	8	2	11
7	0	2	3	5
8	1	2	2	5
9	0	3	3	6
10	3	1	5	9
11	2	2	3	7
12	3	2	6	11
13	2	2	5	9
14	2	0	5	7
15	1	1	3	5
16	0	2	2	4
17	2	0	2	4
18	3	0	4	7
19	1	0	6	7
20	5	2	4	11
21	4	1	3	8
22	2	1	4	7
23	2	1	4	7
24	2	1	4	7
25	5	1	5	11
26	3	2	3	8
27	6	2	3	11
28	3	1	2	6
29	4	8	2	14
30	1	1	5	7
31	5	1	3	9
32	2	1	0	3
33	1	2	2	5
34	2	1	2	5
35	3	1	2	6
36	5	0	1	6
37	2	2	1	5
38	4	1	2	7
39	2	0	1	3
40	0	1	1	2
41	2	1	2	5
42	2	2	2	6
43	0	0	1	1
44	2	1	1	4
45	3	1	2	6
46	4	1	2	7
47	1	0	4	5
48	0	0	3	3
49	2	0	5	7
50	0	1	3	4
51	2	0	4	6
52	4	0	1	5
53	2	0	2	4

Table A22 continued.

Time	Compartment one	Compartment two	Compartment three	Total
54	3	0	2	5
55	4	1	1	6
56	5	0	2	7
57	2	0	5	7
58	2	2	1	5
59	2	2	6	10
60	3	2	5	10
61	2	0	5	7
62	5	2	5	12
63	0	0	1	1
64	5	1	2	8
65	3	2	1	6
66	4	0	3	7
67	3	0	3	6
68	1	0	7	8
69	2	2	5	9
70	4	1	2	7
71	3	3	4	10
72	3	0	1	4
73	3	1	2	6
74	3	0	2	5
75	1	1	2	4
76	3	1	1	5
77	5	0	2	7
78	2	0	2	4
79	5	0	1	6
80	1	0	1	2
81	2	0	3	5
82	2	0	2	4
83	3	1	2	6
84	2	2	0	4
85	2	5	1	8
86	5	0	3	8
87	1	1	4	6
88	1	0	7	8
89	1	0	2	3
90	2	2	2	6

Table A23. Number of horses standing alert at each minute of stop two of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	6	2	3	11
2	6	4	2	12
3	6	4	1	11
4	3	1	2	6
5	3	4	2	9
6	2	0	2	4
7	0	4	3	7
8	5	2	5	12
9	3	1	2	6
10	4	3	2	9
11	2	4	5	11
12	1	3	6	10
13	1	1	5	7
14	4	0	3	7
15	2	0	4	6
16	2	0	2	4
17	3	0	2	5
18	3	2	2	7
19	1	1	3	5
20	3	0	2	5
21	3	0	2	5
22	3	0	2	5
23	2	2	2	6
24	0	3	2	5
25	1	1	2	4
26	3	1	2	6
27	2	2	2	6
28	1	1	1	3
29	4	1	3	8
30	2	2	2	6
31	2	1	2	5
32	3	2	2	7
33	5	2	2	9
34	3	0	2	5
35	0	7	2	9
36	0	6	1	7
37	6	5	3	14
38	2	4	2	8
39	3	0	2	5
40	1	1	1	3
41	2	2	0	4
42	2	3	2	7
43	3	4	2	9
44	3	1	3	7
45	4	5	2	11
46	2	3	1	6
47	4	3	1	8
48	4	3	2	9
49	3	1	0	4
50	0	4	2	6
51	3	4	2	9
52	1	1	1	3
53	5	6	1	12

Table A23 continued.

Time	Compartment one	Compartment two	Compartment three	Total
54	3	4	0	7
55	3	5	2	10
56	3	4	4	11
57	2	0	2	4
58	6	2	3	11
59	2	2	1	5
60	1	1	3	5
61	6	2	2	10
62	1	6	3	10
63	2	1	2	5
64	0	1	3	4
65	2	2	2	6
66	7	1	2	10
67	2	2	1	5
68	4	2	1	7
69	2	4	2	8
70	4	1	2	7
71	3	0	4	7
72	1	3	0	4
73	5	6	0	11
74	4	5	0	9
75	5	4	0	9
76	2	2	1	5
77	3	5	0	8
78	4	5	3	12
79	2	2	4	8
80	2	2	3	7
81	4	4	3	11
82	3	2	3	8
83	3	5	2	10
84	3	1	3	7
85	3	7	1	11
86	3	3	2	8
87	0	0	1	1
88	0	4	2	6
89	5	5	3	13
90	1	5	4	10

Table A24. Number of horses standing alert at each minute of stop three of Shipment Three.

Time	Compartment one	Compartment two	Compartment three	Total
1	4	2	8	14
2	4	4	6	14
3	4	4	4	12
4	3	5	2	10
5	2	2	5	9
6	0	4	2	6
7	4	3	2	9
8	5	3	1	9
9	3	2	2	7
10	3	2	1	6
11	2	1	0	3
12	4	2	3	9
13	1	4	2	7
14	5	1	2	8
15	3	3	2	8
16	2	3	2	7
17	4	2	2	8
18	3	2	3	8
19	3	2	1	6
20	3	1	2	6
21	2	1	2	5
22	0	2	3	5
23	3	3	1	7
24	7	10	3	20
25	3	5	7	15
26	2	4	5	11
27	5	1	2	8
28	2	0	1	3
29	6	2	3	11
30	4	3	3	10
31	8	3	4	15
32	7	2	3	12
33	3	2	2	7
34	4	5	6	15
35	4	4	5	13
36	6	7	5	18
37	5	3	3	11
38	2	1	5	8
39	2	2	3	7
40	2	4	7	13
41	2	4	6	12
42	3	2	6	11
43	5	0	4	9
44	2	6	6	14
45	5	3	3	11
46	2	2	2	6
47	3	4	4	11
48	3	1	2	6
49	3	1	2	6
50	4	0	1	5
51	3	0	1	4
52	6	4	1	11
53	6	5	5	16

Table A24 continued.

Time	Compartment one	Compartment two	Compartment three	Total
54	7	3	6	16
55	5	2	6	13
56	1	0	3	4
57	4	0	2	6
58	3	0	5	8
59	3	0	4	7
60	4	0	2	6
61	4	0	2	6
62	3	0	3	6
63	3	3	2	8
64	7	1	3	11
65	1	0	1	2
66	5	0	1	6
67	4	2	2	8
68	6	2	1	9
69	5	0	2	7
70	3	4	4	11
71	4	0	2	6
72	6	3	2	11
73	3	3	3	9
74	4	0	2	6
75	4	0	3	7
76	4	4	2	10
77	4	0	1	5
78	4	2	1	7
79	6	0	2	8
80	3	1	1	5
81	3	0	1	4
82	4	0	2	6
83	3	0	1	4
84	4	0	2	6
85	2	0	2	4
86	4	1	1	6
87	6	0	4	10
88	5	1	2	8
89	4	0	2	6
90	5	2	1	8

Table A25. Number of horses indiscernible at each minute of stop one of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	2	0	0	2
2	1	1	0	2
3	5	1	0	6
4	1	0	1	2
5	1	1	0	2
6	2	1	0	3
7	1	0	1	2
8	2	0	0	2
9	0	0	0	0
10	0	1	0	1
11	0	0	0	0
12	0	1	0	1
13	0	1	1	2
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	1	1
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	1	0	1
31	0	1	0	1
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	0	1	0	1
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	0	0
41	0	0	0	0
42	0	0	0	0
43	0	0	0	0
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0

Table A25 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	0	0	0	0
65	0	0	0	0
66	0	0	0	0
67	0	0	0	0
68	0	0	0	0
69	0	0	0	0
70	0	0	0	0
71	0	0	0	0
72	0	0	0	0
73	0	0	0	0
74	0	0	0	0
75	0	0	0	0
76	0	0	0	0
77	0	0	0	0
78	0	0	0	0
79	0	0	0	0
80	0	0	0	0
81	0	0	0	0
82	0	0	0	0
83	0	0	0	0
84	0	0	0	0
85	0	0	0	0
86	0	0	0	0
87	0	0	0	0
88	0	0	0	0
89	0	0	0	0
90	0	0	0	0

Table A26. Number of horses indiscernible at each minute of stop two of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	0	0
41	0	0	0	0
42	0	0	0	0
43	0	0	0	0
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0

Table A26 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	1	1
63	0	0	0	0
64	0	0	0	0
65	0	0	0	0
66	0	0	0	0
67	0	0	0	0
68	0	0	0	0
69	0	0	0	0
70	0	0	0	0
71	0	0	0	0
72	0	0	0	0
73	0	0	0	0
74	0	0	0	0
75	0	0	0	0
76	0	0	0	0
77	0	0	0	0
78	0	0	0	0
79	0	0	0	0
80	0	0	0	0
81	0	0	0	0
82	0	0	0	0
83	0	0	0	0
84	0	0	0	0
85	0	0	0	0
86	0	0	0	0
87	0	0	0	0
88	0	0	0	0
89	0	0	0	0
90	0	0	0	0

Table A27. Number of horses indiscernible at each minute of stop three of Shipment One.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	0	0	0
2	0	0	1	1
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	1	0	1
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	0	0
41	0	0	0	0
42	0	0	0	0
43	0	0	0	0
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0

Table A27 continued.

Time	Compartment one	Compartment two	Compartment three	Total
54	0	0	0	0
55	0	0	0	0
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	0	0	0	0
65	0	0	0	0
66	0	0	0	0
67	0	0	0	0
68	0	0	0	0
69	0	1	0	1
70	0	0	0	0
71	0	0	0	0
72	0	0	0	0
73	0	0	0	0
74	0	0	0	0
75	0	0	0	0
76	0	0	0	0
77	0	0	0	0
78	0	0	0	0
79	0	0	0	0
80	0	0	0	0
81	0	0	0	0
82	0	0	0	0
83	0	0	0	0
84	0	0	0	0
85	0	0	0	0
86	0	0	0	0
87	0	0	0	0
88	0	0	0	0
89	0	0	0	0
90	0	0	0	0

Table A28. Number of indiscernible at each minute of stop one of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	0	2	0	2
2	0	3	0	3
3	0	3	0	3
4	0	1	0	1
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	1	0	1
12	0	1	0	1
13	2	1	0	3
14	0	0	0	0
15	1	1	0	2
16	2	1	0	3
17	2	0	0	2
18	1	0	0	1
19	2	0	0	2
20	1	0	0	1
21	1	0	0	1
22	2	0	0	2
23	1	0	0	1
24	1	0	0	1
25	1	0	0	1
26	1	0	0	1
27	1	0	0	1
28	1	0	0	1
29	1	1	0	2
30	1	0	0	1
31	2	0	0	2
32	2	0	0	2
33	1	0	0	1
34	1	0	0	1
35	0	1	0	1
36	1	1	0	2
37	2	0	0	2
38	2	1	0	3
39	2	0	0	2
40	1	0	0	1
41	2	0	0	2
42	2	0	0	2
43	2	0	0	2
44	1	0	0	1
45	0	0	0	0
46	1	0	0	1
47	2	0	0	2
48	2	0	0	2
49	0	1	0	1
50	1	0	0	1
51	2	0	0	2
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0

Table A28 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	0	0	0	0
65	0	0	0	0
66	0	0	0	0
67	0	0	0	0
68	1	0	0	1
69	0	0	0	0
70	1	0	0	1
71	0	1	0	1
72	0	0	0	0
73	0	0	0	0
74	0	0	0	0
75	2	0	0	2
76	0	0	0	0
77	0	0	0	0
78	1	0	0	1
79	1	0	0	1
80	0	0	0	0
81	0	0	0	0
82	1	0	0	1
83	1	0	0	1
84	2	0	0	2
85	2	0	0	2
86	2	0	0	2
87	2	0	0	2
88	2	0	0	2
89	2	0	0	2
90	2	0	0	2

Table A29. Number of horses indiscernible at each minute of stop two of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	2	1	0	3
2	2	0	0	2
3	2	0	0	2
4	2	0	0	2
5	2	0	0	2
6	2	0	0	2
7	2	1	0	3
8	2	1	0	3
9	1	1	0	2
10	0	0	0	0
11	2	0	0	2
12	2	0	0	2
13	2	1	0	3
14	1	1	0	2
15	2	2	0	4
16	2	2	0	4
17	2	2	0	4
18	2	1	0	3
19	2	1	0	3
20	1	1	0	2
21	1	1	0	2
22	2	1	0	3
23	1	0	0	1
24	2	0	0	2
25	2	0	0	2
26	1	1	0	2
27	2	0	0	2
28	2	0	0	2
29	2	0	0	2
30	2	0	0	2
31	2	1	0	3
32	1	0	0	1
33	2	0	0	2
34	2	1	0	3
35	1	0	0	1
36	1	0	0	1
37	0	0	0	0
38	0	0	0	0
39	0	1	0	1
40	1	0	0	1
41	1	0	0	1
42	1	0	0	1
43	0	1	0	1
44	1	0	0	1
45	1	0	0	1
46	1	0	0	1
47	4	0	0	4
48	1	2	0	3
49	2	1	0	3
50	2	1	0	3
51	2	0	0	2
52	2	0	0	2
53	2	0	0	2
54	2	0	0	2
55	1	0	0	1

Table A29 continued.

Time	Compartment one	Compartment two	Compartment three	Total
56	1	0	0	1
57	2	0	0	2
58	2	0	0	2
59	1	0	0	1
60	2	0	0	2
61	1	0	0	1
62	2	0	0	2
63	2	0	0	2
64	2	0	0	2
65	2	0	0	2
66	0	0	0	0
67	1	0	0	1
68	1	0	0	1
69	2	0	0	2
70	2	0	0	2
71	2	1	0	3
72	2	0	0	2
73	2	0	0	2
74	2	0	0	2
75	2	0	0	2
76	2	0	0	2
77	2	0	0	2
78	2	1	0	3
79	2	0	0	2
80	2	1	0	3
81	2	0	0	2
82	2	0	0	2
83	1	0	0	1
84	2	0	0	2
85	1	0	0	1
86	2	2	0	4
87	0	0	0	0
88	2	0	0	2
89	3	0	0	3
90	3	0	0	3

Table A30. Number of horses indiscernible at each minute of stop three of Shipment Two.

Time	Compartment one	Compartment two	Compartment three	Total
1	2	0	0	2
2	1	0	0	1
3	2	0	0	2
4	1	0	0	1
5	1	0	0	1
6	1	0	0	1
7	1	0	0	1
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	1	0	1
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	2	0	2
26	0	1	0	1
27	0	1	0	1
28	0	0	0	0
29	0	0	0	0
30	0	1	0	1
31	0	0	0	0
32	0	0	0	0
33	0	1	0	1
34	0	0	0	0
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	1	0	1
41	0	1	0	1
42	0	0	0	0
43	0	0	0	0
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0

Table A30 continued.

Time	Compartment one	Compartment two	Compartment three	Total
54	0	0	0	0
55	0	0	0	0
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	0	0	0	0
65	0	0	0	0
66	0	0	0	0
67	0	0	0	0
68	0	0	0	0
69	0	0	0	0
70	0	0	0	0
71	0	0	0	0
72	0	0	0	0
73	0	0	0	0
74	0	0	0	0
75	0	0	0	0
76	0	0	0	0
77	0	0	0	0
78	0	0	0	0
79	0	0	0	0
80	0	0	0	0
81	0	0	0	0
82	0	0	0	0
83	0	0	0	0
84	0	0	0	0
85	0	0	0	0
86	0	0	0	0
87	0	0	0	0
88	0	0	0	0
89	0	0	0	0
90	0	0	0	0

APPENDIX B

Table B1. Average beginning and ending temperatures for each stop of Experiment One.

Stop	Average beginning temperature (°C)	Average ending temperature (°C)	Time
Shipment one, Stop one	23.1	22.7	0055 to 0155
Shipment one, Stop two	18.7	21.9	1130 to 1230
Shipment two, Stop one	No data	No data	No data
Shipment two, Stop two	29.6	31.5	1050 to 1150
Shipment three, Stop one	27.6	27.8	0350 to 0450
Shipment three, Stop two	33.8	35.4	1450 to 1550
Shipment four, Stop one	29.3	29.6	2340 to 0040
Shipment four, Stop two	31.9	32.6	0920 to 1020
Shipment five, Stop one	31.4	31.1	2350 to 0050
Shipment five, Stop two	30.6	32.4	1030 to 1130

Table B2. Average beginning and ending temperatures for each stop of Experiment Two.

Stop	Average beginning temperature (°C)	Average ending temperature (°C)	Time
Shipment one, Stop one	30.31	27.39	2045 to 2215
Shipment one, Stop two	24.27	25.82	0415 to 0545
Shipment one, Stop three	32.34	35.56	1130 to 1300
Shipment two, Stop one	33.59	33.73	1915 to 2045
Shipment two, Stop two	27.25	27.78	0315 to 0445
Shipment two, Stop three	31.12	35.56	1045 to 1215

APPENDIX C

Table C1. Number of horses in each treatment for Experiment One, Shipment One.

			Stop one		Stop two	
Density	Water	Total number of horses	Number of horses observed	Weight in compartment	Number of horses observed	Weight in compartment
High	Yes	10	7	10445	3	10445
Medium	Yes	8	6	9225	6	9225
Low	No	5	No data	5455	No data	5455

Table C2. Number of horses in each treatment for Experiment One, Shipment Two.

			Stop one		Stop two	
Density	Water	Total number of horses	Number of horses observed	Weight in compartment	Number of horses observed	Weight in compartment
High	No	13	7	10735	10	10735
Medium	Yes	10	9	9406	9	9406
Low	Yes	7	3	6010	5	6010

Table C3. Number of horses in each treatment for Experiment One, Shipment Three.

			Stop one		Stop Two	
Density	Water	Total number of horses	Number of horses observed	Weight in compartment	Number of horses observed	Weight in compartment
High	Yes	10	4	11343	6	11343
Medium	No	9	4	9841	5	9841
Low	Yes	6	5	6598	5	6598

Table C4. Number of horses in each treatment for Experiment One, Shipment Four.

			Stop one		Stop two	
Density	Water	Total number of horses	Number of horses observed	Weight in compartment	Number of horses observed	Weight in compartment
High	Yes	11	10	10769	8	10769
Medium	Yes	10	7	9571	5	9571
Low	No	5	6	5442	5	5442

Table C5. Number of horses in each treatment for Experiment One, Shipment Five.

			Stop one		Stop two	
Density	Water	Total number of horses	Number of horses observed	Weight in compartment	Number of horses observed	Weight in compartment
High	No	11	No data	11217	No data	11217
Medium	Yes	10	9	9877	No data	9877
Low	Yes	6	No data	6253	4	6253

Table C6. Number of horses and weight in each compartment for Experiment Two.

	Shipment one		Shipment two	
	Number of horses	Weight of compartment	Number of horses	Weight of compartment
Compartment one	11	11543	12	11480
Compartment two	11	10880	10	11174
Compartment three	10	10947	11	11905
Total	32	33370	33	34559

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Gallagher, G.R., H.A. Keen, and R.H. Prince. 2005. Effectiveness of a white-tailed deer exclusion fence based on traction limitations of the hoof: "The Slippery Fence." Proceedings of the Eleventh Wildlife Damage Management Conference (In Press).

Keen, H.A., Wilkerson, R.M., C.A. Taylor and G.R. Gallagher. 2004. Classical conditioning and social learning as a potential sheep management tool. 11th Annual Blue Ridge Undergraduate Research Conference, April 1-2, Milligan College, Johnson City, TN.

Wilkerson, R.W., H.A. Keen and G.R. Gallagher. 2004. Potential of Milorganite to control browsing damage by white-tailed deer on planted chrysanthemums. 11th Annual Blue Ridge Undergraduate Research Conference, April 1-2, Milligan College, Johnson City, TN.

Gallagher, G.R., Keen, H.A., and R.H. Prince. 2003. Effectiveness of a perceived solid barrier as an exclusion fence to prevent white-tailed deer damage. Proceedings of The Tenth Wildlife Damage Management Conference 10:23-29.

Keen, H., Gallagher G.R., T. Touchstone and R.H. Prince. 2003. The potential of altering texture as a deer deterrent: The slime effect. Proceedings of The Tenth Wildlife Damage Management Conference 10:429.